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Environmental Impact Statement

for the Revised Land and Resource Management Plan

Forest Service | Region 8 | George Washington National Forest | R8-MB 143 D | November 2014

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Final Environmental Impact Statement for the George Washington National Forest Land and Resource Management Plan

Alleghany, Amherst, Augusta, Bath, Botetourt, Frederick, Highland, Nelson, Page, Rockbridge, Rockingham, Shenandoah, and Warren Counties in Virginia.

Hampshire, Hardy, Monroe and Pendleton Counties in West Virginia.

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ABSTRACT

The Forest Service revises the 1993 Land and Resource Management Plan for the George Washington National Forest. The Revised Plan updates the management direction for the Forest's 1.1 million acres of land in Virginia and West Virginia by describing desired conditions, goals, objectives, suitable uses, standards and monitoring requirements. In accordance with the National Environmental Policy Act of 1969, the Forest has prepared a Final Environmental Impact Statement (FEIS) for the Revised Plan. The FEIS provides the purpose and need for Plan revision, presents issues addressed, describes management alternatives considered to respond to those issues, and analyzes the potential environmental effects of the alternatives. The Environmental Impact Statement describes nine alternatives including a "no action" alternative that would continue managing the land and resources of the Forest under the 1993 Forest Plan as amended. The Forest Service has selected Alternative I.

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INTRODUCTION

The purpose of this proposed action is to revise the George Washington Land and Resource Management Plan (Forest Plan). The revised Forest Plan guides all natural resource management activities on the George Washington National Forest to meet the objective of Federal law, regulations, and policy. The proposed action also affects a wide range of socioeconomic factors, as they relate to natural resources. The existing Forest Plan for the George Washington National Forest was approved January 21, 1993. There have been ten amendments to the existing Forest Plan. Revision of the Forest Plan is now needed to satisfy regulation requirements and to address new information about the forest and its uses.

The George Washington and Jefferson National Forests were administratively combined in 1995. However, each National Forest continues to have its own Forest Plan. The Forest Plan applies to the George Washington National Forest for a total of approximately 1,066,000 acres.

This Final Environmental Impact Statement (FEIS) describes the analysis of several alternatives for revising the Forest Plan for the George Washington National Forest and discloses the environmental effects of these alternatives. The FEIS is guided by the implementing regulations of the National Environmental Policy Act (NEPA) of 1969 found in the Council of Environmental Quality Regulations, Title 40, CFR, Part 1500. The companion document to this FEIS is the Forest Plan - a detailed presentation of the selected alternative. The selected alternative is Alternative I.

Notification of initiation of the plan revision process for the George Washington National Forest was provided in the Federal Register on February 15, 2007 [72 FR 7390]. The plan revision was initiated under the planning procedures contained in the 2005 Forest Service planning rule (36 CFR 219 (2005)) and one series of public meetings was held. On March 30, 2007, the federal district court for the Northern District of California enjoined the Forest Service from implementing the 2005 planning rule and the revision of the GWNF Forest Plan under the 36 CFR 219 (2005) rule was suspended in response to the injunction. On April 21, 2008 the Forest Service adopted the 2008 Planning Rule that allowed resumption of the revision process if it conformed to the new planning rule (36 CFR 219.14(b) (3) (ii), 2008). Notification of adjustment for resuming the land management plan revision process under the 2008 Planning Rule for the GWNF was provided in the Federal Register on June 24, 2008 [73 FR 35632]. A series of five topical public meetings were held between July 2008 and February 2009. On June 30, 2009, the 2008 Planning Rule was enjoined by the United States District Court for the Northern District of California (<u>Citizens for Better Forestry v. United States Department of Agriculture</u>, No. C 08-1927 CW (N.D. Cal. June 30, 2009)) and the revision of the GWNF Forest Plan was again suspended. The Department then determined that the 2000 Planning Rule was in effect. The 2000 Rule's transition provisions (36 CFR 219.35), amended in 2002 and 2003 and clarified by interpretative rules issued in 2001 and 2004, and reissued on December 18, 2009 [74 FR 67059-67075] allowed use of the provisions of the National Forest System land and resource management planning rule in effect prior to the effective date of the 2000 Rule (November 9, 2000), commonly called the 1982 planning regulations, to amend or revise plans. The GWNF elected to use the provisions of the 1982 planning regulations. On March 10, 2010 a Notice of Intent to prepare an environmental impact statement and revised land management plan using the provisions of the 1982 National Forest System land and resource management planning regulations for the George Washington National Forest was published in the Federal Register [75 FR 11107]. The current Planning Rule, published on April 9, 2012, also allows for plan revisions initiated before May 9, 2012 to be revised in conformance with the provisions of the prior planning regulations, including its transition provisions (36 CFR part 209, published at 36 CFR parts 200 to 209, revised as of July 1, 2010).

The information gathered from public collaboration efforts and most of the analysis conducted prior to the court's injunction in June 2009 remained useful for completing the plan revision using the provisions of the 1982 planning regulations. The GWNF concluded that the following material developed during the plan revision before the 2010 Notice of Intent was appropriate for continued use:

- The inventory and evaluation of potential wilderness areas published on August 21, 2008 was consistent with the 1982 planning regulations, and was brought forward into the plan revision process.
- A Comprehensive Evaluation Report (CER) was developed under the 2005 and 2008 rule provisions, and it was available for public comment. This analysis was updated with additional information to meet the requirements of the Analysis of the Management Situation (AMS) provisions of the 1982 rule. The information from this analysis was used to help identify the need for change and the preliminary proposed actions that were identified in the 2010 Notice of Intent. Comments received during the scoping process were used to further update the need for change analysis.
- Information on the life history, threats, habitat needs and population trends for a number of terrestrial and aquatic species contained in the forest planning records for the ecosystem and species diversity assessments were used as a reference in the planning process as appropriate to meet the requirements of the 1982 planning regulations. This was scientific information and was not affected by the change of planning rule.
- Public comments previously submitted in writing, or recorded at past public meetings, related to the revision of the GW Forest Plan since 2007 were used to help identify issues and concerns and to help develop alternatives to address these issues and concerns.

FOREST PROFILE

The George Washington National Forest extends for about 140 miles along the Appalachian and Blue Ridge Mountains of northwestern Virginia and adjacent West Virginia. The George Washington National Forest comprises lands located in Virginia (approximately 960,282 acres) and West Virginia (approximately 105,099 acres) and is close to a population of about 10.5 million people. The Forest contains the Lee, North River, Warm Springs, James River and Pedlar Ranger Districts. See Figures 1-1 and 1-2.

The National Forest is located in the Northern Blue Ridge and the Northern Appalachian Ridges and Valleys, providing habitat for a wide variety of species including at least 70 amphibian and reptiles, 180 species of birds, 60 species of mammals, and 100 species of freshwater fishes and mussels. Ten of the plants and animals species found on, or near, the Forest are listed by the US Fish and Wildlife Service as threatened or endangered. The Forest affords excellent opportunities for wildlife viewing, as well as hunting and fishing.

The George Washington National Forest is a part of the Appalachian Hardwood Forest which is located within the Eastern Deciduous Forest Province. There are over 60 tree species represented on the National Forest. Hardwood-dominated forest types comprise over 75 percent of the acreage. There is much variation in the vegetation and many natural changes are taking place as forest succession progresses.

The George Washington and Jefferson National Forests together have an average of 44 wildfires each year, with the average size approximating 55 acres. Seventy-five percent of the wildfires are human-caused. Research indicates that fire played a major role in establishing and maintaining the plant communities of the Appalachian Mountains. Major insect pests include the gypsy moth, southern pine beetle, and hemlock woolly adelgid. Major disease problems include oak decline, dogwood anthracnose, and shoestring root rot.

The Forest is located within two major river basins (the James and the Potomac Rivers) and is entirely within the Chesapeake Bay watershed. The Forest contains 1,171 miles of perennial streams, of which over 700 miles support a cold water fishery. At least 30 communities use water from the Forest for all or part of their water supplies.

The Forest transportation network has about 1,800 miles of National Forest System Roads which range from paved highways to non-surfaced roads designed for high clearance vehicles. Many of these roads are available for pleasure driving, the removal of forest products, bicycling and scenic viewing. Interstate 81 and other U.S. and State highways also cross or adjoin the National Forest. The National Forest is also traversed by the Blue Ridge Parkway.

Developed recreation opportunities are offered at about 60 sites on the Forest. The Forest has approximately 1,100 miles of non-motorized trails. The Forest also has six designated Wildernesses, totaling approximately 43,000 acres and one designated National Scenic Area.

There are three individual ATV trail systems offering a total of about 65 miles of motorized trails. The George Washington National Forest encompasses approximately 48 percent of the public hunting lands located in Virginia (the combined George Washington and Jefferson National Forests comprise about 80 percent). Hunting is among the most popular recreation activities on the Forests. The Forests provide the majority of the black bear and ruffed grouse habitat in Virginia.

The George Washington National Forest has very limited energy resource development at the current time. Only about 10,200 acres of the Forest is currently leased under federal oil and gas leasing procedures. Mineral rights on about 16 percent of the Forest are privately owned.

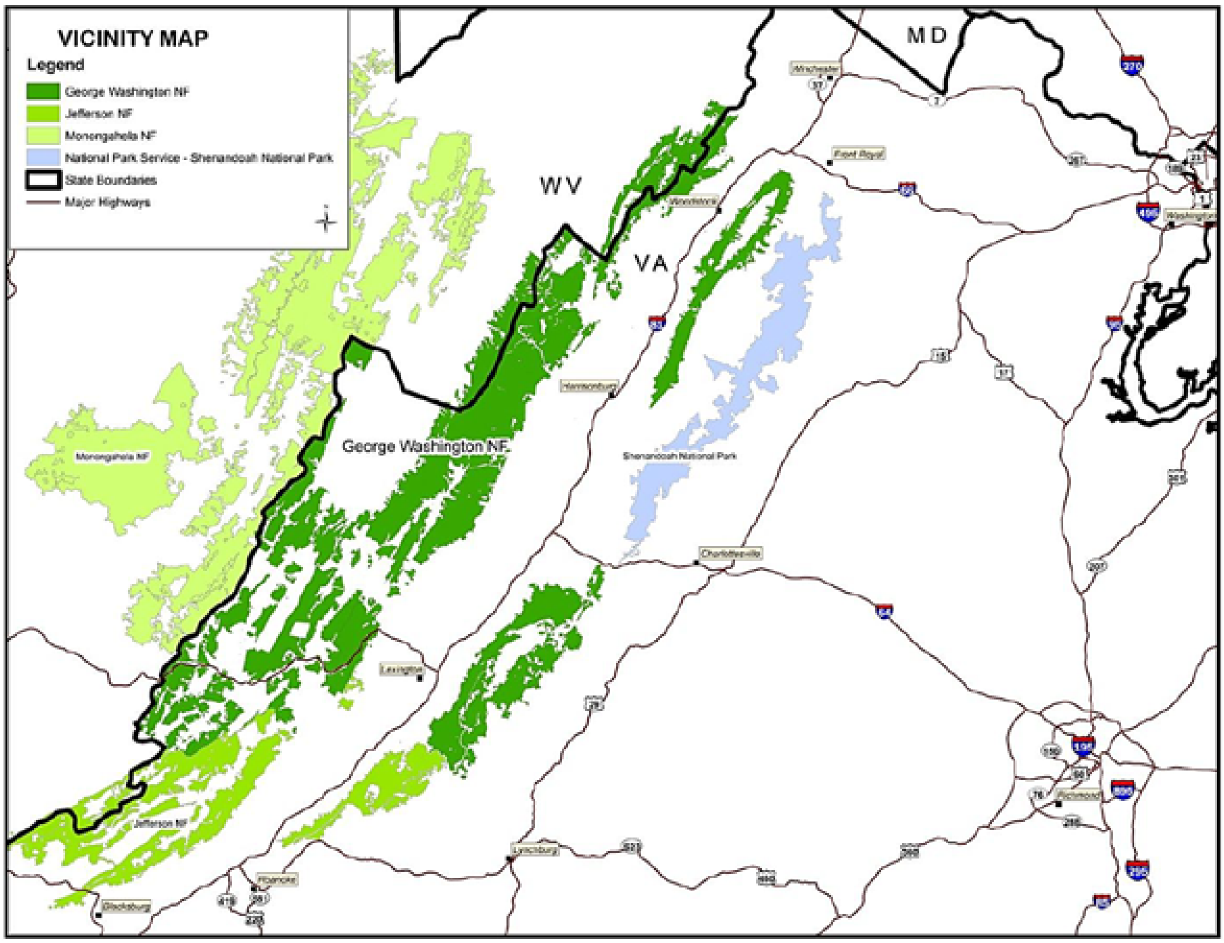

Figure 1-1. Vicinity Map

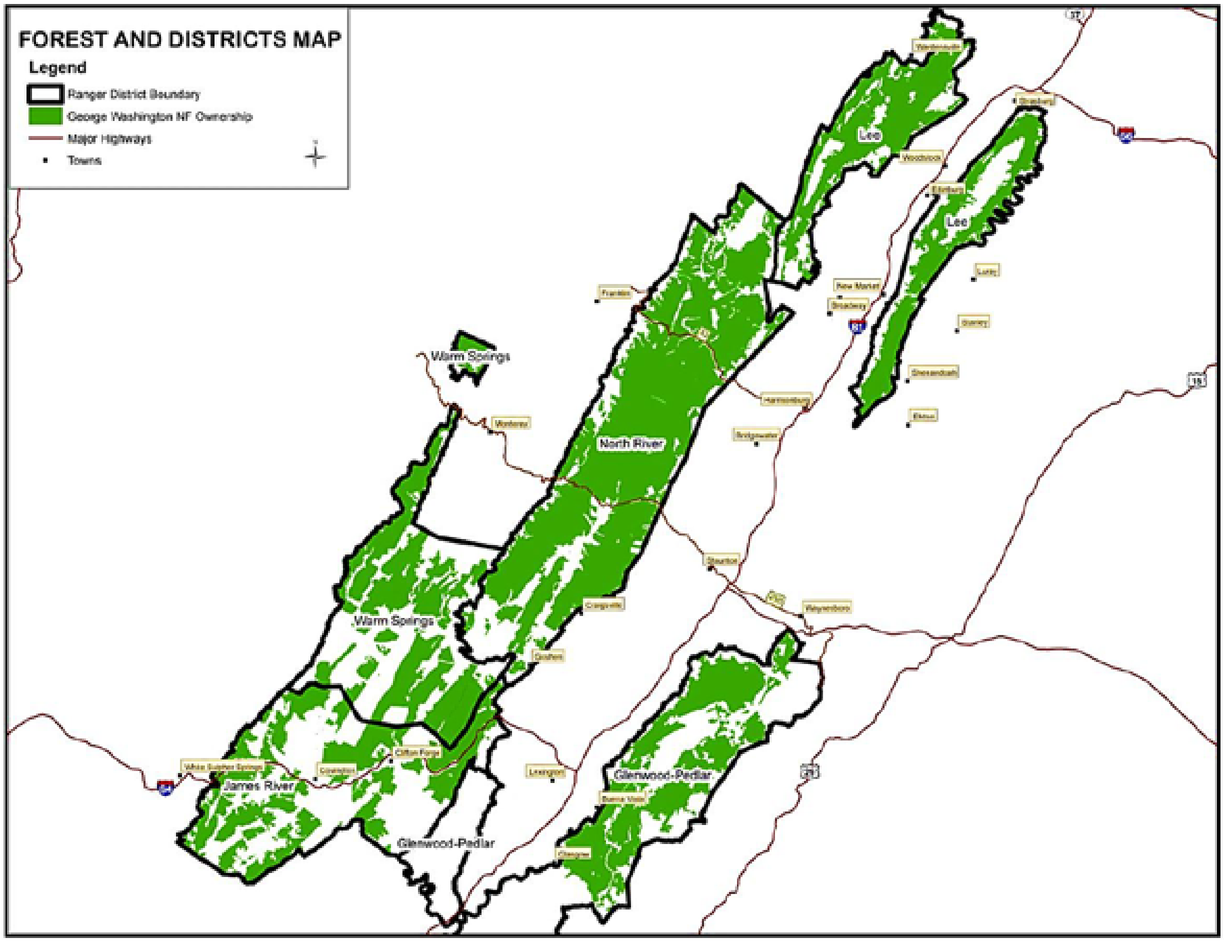

Figure 1-2.Ranger Districts on the George Washington National Forest

PROPOSED ACTION

The proposed action is to revise the 1993 Land and Resource Management Plan for the George Washington National Forest. The proposed action also includes the determination of the National Forest System lands that will be administratively available for oil and gas leasing, as well as the associated stipulations. The Forest Service considers the leasing availability decision to be separate from planning decisions, but it is closely linked to planning decisions. Therefore, the leasing availability decision is also evaluated within this Final Environmental Impact Statement.

PURPOSE AND NEED

The regulations implementing the National Forest Management Act of 1976 (NFMA) instruct the Regional Forester to make periodic revisions to forest plans and to provide the basis for any revision. The following section describes the need to change the 1993 Forest Plan and presents the basis for the proposed changes within the context of the regulatory requirements. The instructions to revise forest plans, the basis for revision, are found in Code of Federal Regulations 36 CFR 219.10(g), using the 1982 planning regulations as allowed in the 2012 and 2000 Planning Rules.

The purpose for revising the Forest Plan is to provide a revised Plan that will:

- Guide resource management activities on the Forest for the next 10 to 15 years;
- Address changed conditions and direction since the 1993 Plan was prepared;
- Assure the production and protection of high quality water for National Forest resources and downstream water users;
- Maintain or restore long-term ecosystem health and integrity;
- Contribute to the economic and social needs of people, cultures and communities;
- Meet the objectives and requirements of federal laws, regulations, and policies;
- Provide consistent direction at the Forest level that will assist managers in making project decisions at a local level in the context of broader ecological and social considerations.

The need for this proposed action is to meet the intent of 36 CFR 219.10(g) that land management plans are ordinarily revised on a 10 to 15 year cycle. The existing Forest Plan for the George Washington National Forest (GWNF) was approved on January 21, 1993. Since then, changes have occurred in resource conditions, environmental stresses and threats, societal demands, and our current state of scientific knowledge.

The following have been identified as items to be evaluated as needs for change from the current Plan. Changes are needed in management direction for maintaining or restoring healthy, resilient forest ecosystems due to the recognition that: vegetation conditions (structure, composition, and function) for some ecosystems have declined (e.g. oak regeneration, fire dependent pine regeneration); forest conditions indicate a substantial departure from natural fire regimes; stresses and threats from insects, diseases, and non-native invasive plant and animal species are increasing; and potential effects from climate change are uncertain. By restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems, the GWNF should also provide for the needs of the diverse plant and animal species on the forest. The issue of vegetation management (where, how much, what type) is closely related to this topic because it is one of the tools by which the desired conditions and objectives for ecological health and sustainability can be accomplished.

Specific items needing to change include:

- Better definition of desired conditions and objectives to maintain the resilience and function of identified ecological systems and determination of the desired structure and composition of those ecosystems;
- Management direction to provide habitat for maintaining species viability and diversity across the forest;
- Evaluation of new or expanded existing Special Biological Areas to protect and restore rare communities and species;
- Recognition of the role of fire as an essential ecological process;
- Incorporation of the use of wildfires for achieving ecological objectives;
- Incorporation of management direction for controlling, treating or eradicating non-native invasive plant and animal species;
- Update of the Management Indicator Species (MIS) list;
- Update of the direction for management of old growth to meet guidance for the Southern Region;
- Incorporation of adaptive management strategies for addressing climate change;
- Identification of the importance of maintaining the high quality of water for drinking water and for aquatic life;
- Evaluation of the riparian corridor distance definition and updating the standards for riparian area protection to incorporate the best available science;
- Strengthening of the management direction for groundwater and karst areas;
- Re-evaluation of the oil and gas leasing availability designations;
- Re-evaluation of the appropriate mix of recreational experiences that is sustainable and responsive to user demand;
- Evaluation of areas for recommendation of congressional designation, such as wilderness or national scenic area;

- Identification of uses suitable for specific areas of the forest (e.g. timber production, road construction, wind energy development, prescribed fire);
- Determination of the mix of vegetation management (where, how much, what type) as one of the tools by which the desired conditions and objectives for ecological health and sustainability can be accomplished;
- Determination of the allowable sale quantity of timber;
- Evaluation of road access needs.

In 2008, an inventory of Potential Wilderness Areas was completed that identified 37 areas (totaling about 370,000 acres) that meet the definition of wilderness in section 2(c) of the 1964 Wilderness Act. This inventory included almost all of the remaining 2001 Inventoried Roadless Areas. An evaluation based on the capability (degree to which each area contains the basic natural characteristics that make it suitable for wilderness designation), the availability (value of and need for the wilderness resource compared to the value of and need of each area for other resources) and the need (degree that the area contributes to the local and national distribution of wilderness) for additional wilderness has been conducted for these areas (Appendix C).

FOREST PLAN DECISIONS

National Forest System resource allocation and management decisions are made in two stages. The first stage is the Forest Plan, which allocates lands and resources to various uses or conditions by establishing management areas and management prescriptions for the land and resources within the plan area. The second stage is approval of site-specific project decisions.

Forest plans do not compel the agency to undertake any site-specific projects; rather, they establish overall goals and objectives (or desired resource conditions) that the individual national forest will strive to meet. Forest plans also establish limitations on what actions may be authorized, and what conditions must be met, during project decision making. Project decision making must comply with National Environmental Policy Act (NEPA) procedures and must be consistent with the Forest Plan.

The primary decisions made in a Forest Plan include:

1. Forest multiple-use goals and objectives that include a description of the desired conditions of the forest and an identification of the quantities of goods and services that are expected to be produced or provided [36 CFR 219.11(b)].
2. Establishment of multiple-use prescriptions for each management area, including proposed and probable management practices [36 CFR 219.11(c)].
3. Establishment of management requirements, including associated standards and guidelines that would apply to implementation of the Forest Plan [36 CFR 219.11(c), 219.13 to 219.27].
4. Descriptions of lands suitable or not suitable for specific resource activities, including timber production [(16 USC 1604(k) and 36 CFR 219.14)].
5. Establishment of the Allowable Sale Quantity (ASQ) of timber to ensure a sustained yield of wood products in perpetuity [16 USC 1611 and 36 CFR 219.16].
6. Identification of lands as preliminary administrative recommendations for inclusion in the National Wilderness Preservation System [36 CFR 219.17; FSH 1909.12, Chapter 73.11].
7. Identification of Research Natural Areas (RNAs), which are examples of important forest, shrubland, grassland, alpine, aquatic, and geologic types that have special or unique characteristics of scientific interest and importance and that are needed to complete the national network of RNAs [36 CFR 219.25].
8. Identification of river segments that are suitable for inclusion in the National Wild and Scenic Rivers System [PL 90-542; 36 CFR 219.2(a)].

9. The monitoring and evaluation requirements needed to ensure that Forest Plan direction is carried out and to determine how well outputs and effects were predicted [36 CFR 219.11(d)].

In addition to the analysis needed for Forest Plan decisions, this EIS also includes the analysis needed to make the decision on lands available for oil and gas leasing. The lands administratively available to leasing decision for the Revised Forest Plan was developed based on the law and the implementing regulations (36 CFR 228E) as well as the wide range of laws applicable to National Forest System lands.

THE RESPONSIBLE OFFICIAL

The Regional Forester is the responsible official for the analysis and decisions in this Forest Plan revision. Conducting analysis, developing alternatives, and preparing the FEIS were done at the local Forest level under the direction of the Forest Supervisor for the George Washington and Jefferson National Forests.

SUPPORTING ENVIRONMENTAL ANALYSES

The following documents contain environmental analyses that are not repeated in this EIS, but provide supporting documentation for some of the Forest Plan decisions.

- Final Environmental Impact Statement for *Gypsy Moth Management in the United States: a Cooperative* Approach (Washington, DC: USDA Forest Service and APHIS, 5 volumes. November, 1995)
- Final Supplemental Environmental Impact Statement for "Gypsy Moth Management in the United States: a Cooperative Approach" (Newtown Square, PA, USDA Forest Service and APHIS, 4 Volumes, August, 2012)
- Final Environmental Impact Statement for the *Suppression of the Southern Pine Beetle* (Atlanta, Georgia: USDA Forest Service, Southern Region, April 1987)
- Final Environmental Impact Statement for *Vegetation Management in the Appalachian Mountains* (Atlanta, Georgia: USDA Forest Service, July 1989)
- Environmental Assessment for *Management of the Federally Endangered Indiana Bat* (Roanoke, VA: USDA Forest Service, George Washington and Jefferson National Forest, March 1998)
- *Conservation Assessment For The Cow Knob Salamander 1994*

PLANNING PROCESS

Forest planning occurs within the overall framework provided by implementing the regulations of NFMA and NEPA. National, regional, and forest planning form an integrated three-level process. This process requires a continuous flow of information and management direction among three Forest Service administrative levels.

Planning actions required by the NFMA and used in this planning process are:

- Identification of issues, concerns, and opportunities;
- Development of planning criteria;
- Inventory of resources and data collection;
- Analysis of the Management Situation;
- Formulation of alternatives;
- Estimation of effects of alternatives;
- Evaluation of alternatives;
- Recommendation of preferred alternative;
- Approval and implementation;
- Monitoring and evaluation.

The results of these planning steps are described in this document. Refer to Appendix B-*Analysis Process*, for more detail on the results of some of these steps.

SUMMARY OF SIGNIFICANT ISSUES

Public involvement is a key part of the planning process. Providing for public comment helps identify what people want from the national forests in the form of goods, services, and environmental conditions. Issues submitted by the public, as well as from within the Forest Service and other federal and state agencies, guided the need to change current management strategies. A detailed account of the public involvement process is in Appendix A-*Summary of Public Involvement*.

The following significant issues were used to formulate alternatives, prescribe mitigation measures, or analyze environmental effects among alternatives.

Access

ISSUE STATEMENT: Forest management strategies may affect the balance between public and management needs for motorized access to Forest lands (for recreation, hunting, management activities, fire suppression) and protection of soil and water resources, wildlife populations and habitat, aesthetics, forest health, and desired vegetation conditions.

BACKGROUND: System roads are the primary means of motorized access to the national forest. However, they are also a source of concerns including the environmental effects of roads (on water quality, soil erosion, and habitat) and the social effects on remote settings. Some people would like to see the motorized access to the national forests increased, especially during hunting seasons for big game, for other recreational uses, or to meet forest management needs. Other people, however, feel that road construction should be limited and some existing roads decommissioned. Other comments were made that new roads should not be constructed for the purposes of logging or for off-highway vehicle use. The amount of motorized access will need to be balanced with wildlife habitat needs, the need to provide both motorized and non-motorized recreational opportunities, the need to protect the soil and water resources, the need to have management access, and the financial capability of maintaining safe and environmentally secure roads.

Watersheds, Soil and Water Quality, Riparian Resources and Aquatic Diversity

ISSUE STATEMENT: Management activities may affect soil quality, water quality (surface and groundwater) and riparian resources, including drinking water watersheds and those watersheds with streams impaired due to activities off the Forest. Management activities may affect the maintenance and restoration of aquatic biodiversity and may affect species with potential viability concerns.

BACKGROUND: Providing favorable flows of water was the main objective of the Organic Administration Act that created the forest reserves and of the Weeks Law that allowed the purchase of lands for National Forests in the eastern U.S. Water continues to be one the most important resources produced on the Forest. A number of communities in Virginia and West Virginia obtain their drinking water from the National Forest, whether their water supply watershed is completely within the Forest boundary or their supply is a river that is downstream from the Forest. The Forest is also an important component of the Chesapeake Bay watershed. There are streams within and downstream of the Forest that have impaired water quality, although most of these impairments are due to acid deposition or to agriculture and none have been attributed to management activities on the Forest. Water quality and aquatic systems can be affected by acid deposition, roads, trails, past storm events, insects and disease, non-native invasive species and other disturbances. Streams on the forest provide habitat for a number of species at risk, including brook trout and the James spinymussel. The projections for climate change in this area indicate an increase in temperature, which could affect aquatic species, especially trout populations. Climate change projections are more uncertain on whether precipitation will increase or decrease in the southeast over the next 30-100 years but droughts or extreme weather events

each would have impacts to future water quantity and quality conditions. Climate change could also increase acid deposition effects on soil productivity. Currently, the biggest concerns for aquatic habitats on the Forest are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, impacts from roads, and acid deposition.

Terrestrial Biological Diversity

ISSUE STATEMENT: Forest Plan management strategies may affect the maintenance and restoration of the diverse mix of terrestrial plant and animal habitat conditions and may affect species with potential viability concerns.

BACKGROUND: Ecological communities provide the foundation for biological diversity. Ecosystems identified on the Forest include ecological communities that predominate on the landscape (e.g. Central Appalachian Dry Oak-Pine Forest); communities that are declining, rare, or unique (e.g. Caves and Karstlands); and communities that provide habitat for species with potential viability concerns (e.g. Special Biological Areas). For the GWNF, management of ecological communities primarily involves the use of timber harvest and fire to influence vegetation composition and structural diversity of habitats. Some comments were concerned about the current age class distribution on the forest being too skewed toward the mid- to late-successional habitats and that management is needed to provide a mosaic of habitats, especially early successional habitat, which is needed by many species. They cited bird and animal species in decline that require early successional habitat at some point in their life cycle. Others thought the focus on the GWNF should be on providing habitat for species requiring late successional habitat or large home ranges since these conditions are rarer on private lands. They stated that private lands can provide for early successional habitat needs and natural disturbances can create openings on the Forest. Some comments identified the importance of the oak-hickory community in the Central and Southern Appalachians for species diversity and are concerned about oak regeneration and the continuity of future hard mast production.

Old Growth

ISSUE STATEMENT: Forest management strategies may affect the potential biological and social values associated with the abundance, distribution and management of existing and future old growth.

BACKGROUND: Nearly all the lands that became the George Washington National Forest had been cut over at least once before becoming National Forest System lands. However, there are stands of trees that have reached the ages and structural conditions that qualify as “old growth” under the current definitions used in the Southern Region of the Forest Service. Old growth provides both biological and social values. Old growth communities provide large den trees for wildlife species such as black bear, large snags for birds and cavity nesters, and large cover logs for other wildlife. Ecologically, old growth provides elements for biologic richness, gene conservation, and riparian area enhancement. Old growth areas provide for certain recreational experiences, research opportunities, and educational study. Other areas have associated historical, cultural, and spiritual values. Some people may never visit an old growth site but receive satisfaction from just knowing that it exists. On the other hand, old growth areas can be a source of large-diameter, high-value hardwoods, which are limited in supply and in high demand for such products as furniture and finish construction work. Others say that insect and disease risk can be relatively high in old growth stands and could (for some community types) threaten the retention of those stands as old growth. There is concern that fire exclusion could favor a buildup of fire-intolerant, but shade-tolerant, species that could eventually replace the original old growth forest type. Another view is that active management, including timber harvest and prescribed fire, could be used to accelerate the development of old growth attributes.

Forest Health

ISSUE STATEMENT: Forest Plan management strategies may affect the spread and control of non-native invasive species, forest pests, and pathogens, all of which have the potential to affect long-term sustainability, resiliency, and composition of forest ecosystems.

BACKGROUND: While the term "Forest Health" can have several meanings, it is used here to identify the effects of forest pest problems and non-native invasive species. It is a dynamic concept that considers the conditions of our forested ecosystems when subjected to insect and disease organisms and/or invasive species that may otherwise contribute to poor development. While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. These include a wide variety of organisms such as the chestnut blight fungus, gypsy moth, hemlock woolly adelgid, didymo algae, and Ailanthus. In addition to these non-native pests, it also includes the native pine bark beetles. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpation of rare species; impacts to recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Control of existing populations, prevention of the spread of known pests, mitigation of existing problems, and prevention of the introduction of new pests are all components of this issue.

Wind Energy

ISSUES STATEMENT: Responding to opportunities to develop wind energy generation may result in effects on a wide variety of resources (including birds, bats, scenery, trail use, soils on ridgetops, water, noise, remote habitat, local communities/economies, and social values).

BACKGROUND: Wind energy is renewable and can reduce the use of fuels generating carbon gases and positively affect climate change. The USDA Forest Service and National Renewable Energy Laboratory (2005) identified 35,810 acres (primarily ridgetops) of the GWNF with a high potential for wind area development. The GWNF is in close proximity to growing population centers that would benefit from additional and clean energy production. However, there are concerns about the effects to water, birds, bats, views, visuals, aesthetics (height of towers), noise, carbon sequestration, and fragmentation of habitat. These concerns relate to both construction and operation of the wind turbines and the associated infrastructure development to support the turbines (roads, distribution grid). Some people believe that this need for wind energy development can and should be met on private lands, or are concerned that the power would not be used to solve local needs. Other people believe that the public lands should contribute to the development of renewable resources and green energy.

Oil and Gas Leasing

ISSUE STATEMENT: Use of National Forest System lands to support energy needs through federal oil and gas leasing may affect forest resources and impact adjacent private lands.

BACKGROUND: Energy production has long been a component of National Forest System management and gas development provides energy to meet national needs. There are no active gas wells currently in production on the Forest and only about 10,200 acres are currently under lease for gas and oil. A particular type of gas well operation is the development of gas deposits within the Marcellus shale formations, through horizontal drilling and the use of hydraulic fracturing at numerous locations throughout the horizontal bore holes. Concerns about hydraulic fracturing include the quantity of water needed in the process, negative effects on water quality (ground and surface), wildlife, air quality, viewsheds, forest fragmentation, and ecotourism. Some public comments identified that developing Marcellus shale gas is okay when it is properly regulated and that National Forest System land should be available for leasing Marcellus shale so that people can maintain their standard of living and meet energy needs. Development of the Marcellus shale would bring jobs and income to the local economy. Other comments stated that there must be an effects analysis for hydraulic fracturing or that there should be a moratorium on development until federal/state regulations are in place and an on-going EPA study is complete. Other comments are opposed to this development or want limitations on where it could be used.

Fire

ISSUE STATEMENT: The management of fire to achieve goals related to protection of property, wildlife habitat, ecosystem diversity and fuels management may affect air quality, non-native invasive species, recreation, water quality, wildlife, and silviculture.

BACKGROUND: Fire is acknowledged as an important part of some ecosystems on the Forest. Aggressive control of wildfire (unplanned ignitions) throughout much of the twentieth century resulted in changes to these ecosystems. Management of wildfires and prescribed fire can serve to restore and maintain these ecosystems, while also protecting National Forest and adjacent lands from the negative effects of fire. Some people support the continued use, and advocate an increase in the use, of prescribed fire to restore ecosystems, create habitat, encourage oak regeneration and reduce fuels. Some comments support the proposed increase in use of prescribed fire, but caution that fire does not replace timber harvest as a management tool; rather it should be considered an additional option for timber management. Some comments identified concerns with the burning program including impacts on adjoining private land, carbon emissions, impacts on native vegetation, opening up habitat for non-native invasive plants, stream sedimentation, and air pollution. Some comments indicated support for using lightning ignited fires to achieve ecosystem restoration goals.

Recreation

ISSUE STATEMENT: Forest management strategies should determine an appropriate mix of sustainable recreational opportunities (including trail access) that responds to increasing and changing demands and also provides for public health and safety and ecosystem protection (such as soil and water resources, nesting animals, riparian resources and spread of non-native invasive species).

BACKGROUND: The Forest is within a day's drive for a large population of people in the eastern U.S. Local and regional visitors use the forest for a variety of recreational opportunities, from primitive hiking and camping to developed recreation sites and motorized travel. Developed recreation is not a significant issue; however, demand for long-distance trails for special recreation events, such as long-distance mountain bicycling, equestrian endurance rides and runner marathons, has increased in recent years. The demand is greatest among the equestrian and mountain biking communities. The public demand for motorized trail opportunities exceeds the national forest supply. Private lands are not a measurable provider at this time. Some comments stated that off-highway and all-terrain vehicle use is not appropriate at all on the Forest due to the noise, potential environmental damage, and the need could be met commercially on private lands.

Wilderness/Roadless

ISSUE STATEMENT: Forest management strategies may affect the balance between the desires for permanent protection of remote areas and the desires for management flexibility and ability to respond to changes in ecological, social and economic conditions when identifying areas to be recommended for Wilderness and determining how potential wilderness areas and other remote areas should be managed.

BACKGROUND: Management of remote areas on the Forest continues to be one of the most prominent issues raised in comments. Remote areas include existing Wilderness, the Inventoried Roadless Areas identified in the 1993 GW Forest Plan Revision (and incorporated into the 2001 Roadless Area Conservation Rule), and the Potential Wilderness Areas (identified as areas meeting the definition of wilderness that need to be evaluated in the current revision process). Public rationale for additional wilderness includes: ecological values of remote, intact areas; recreational values; proximity of large masses of people to the Forest; protection of watersheds through permanent protection; carbon sequestration; ability for latitudinal range adjustments for species due to climate change; future scientific reference; and a need to bring the amount of wilderness on the Forest more in line with amounts on other National Forests. Public rationale opposing wilderness includes: lack of balance of forest age classes (many species are threatened without early successional habitat); limitations on recreation use by those less physically fit; limitations on group size for recreation events; limitations on special use events; prohibiting all motorized and mountain bike access; restrictions on treatment of invasive species;

limitations on meeting energy resource demands; limitations on emergency access; firefighting restrictions; and limiting options as conditions or future demands change.

The GWNF has 23 Inventoried Roadless Areas (IRAs) with a total of 242,278 acres. As part of the revision process, the Forest has identified 37 areas as Potential Wilderness Areas (PWAs) with a total of 372,631 acres. The PWA inventory includes all of the IRAs, with the exception of Southern Massanutten and The Friars. For the remote areas in the PWA inventory that are not identified for Recommended Wilderness Study by Congress, some people would like to see them managed according to the direction in the 2001 Roadless Area Conservation Rule (RACR) and others would like to see them actively managed for wildlife habitat and timber production.

Timber Harvest

ISSUE STATEMENT: Forest Plan management strategies may affect: a) the amount and distribution of land suitable for the sustainable harvest of timber products; b) the amount of timber offered by the Forest; c) the role of timber harvest in benefitting local economies and other multiple use objectives; and d) the methods used to harvest the timber. If the Forest responds to needs for biomass for energy production, whole tree harvesting may affect nutrient cycling, wildlife habitat, and soil productivity and stability. Timber harvest may have effects on other resources.

BACKGROUND: Timber harvest is one of the tools used to manage vegetation on the Forest to create a diversity of habitat conditions. It also produces wood products that benefit local economies. The ecological, social, and economic effects of the timber management program on the GWNF, both positive and negative, are of great importance to many. Some people state that the forest should reduce the acres suitable for harvest, reduce the Allowable Sale Quantity (ASQ), and decrease the commercial timber program due to adverse impacts to: water quality, competition with private lands, air quality, scenery, ecological habitats such as large areas of intact forest (fragmentation), and a wide variety of other ecological/environmental resources. Some indicate that commercial timber harvest on the Forest is not economically viable and competes with privately held timber, that demand for timber can be met on private land, or that the level of the timber sale program should be based on reasonable budget expectations. Other people support an expanded timber program because of the positive impacts on: balancing age classes and reducing acres of an aging forest, maintaining species composition, wildlife habitat, responding to an increased demand for wood products (including small diameter utilization), reduction of hazardous fuels, and benefits to local economies. Therefore, there should be an increase in suitable acres and Allowable Sale Quantity.

The potential use of forest wood and fiber as biomass for energy production raises concerns on the effects on carbon sequestration and on the removal of too much organic material which could increase soil erosion and/or remove too many nutrients from the site, particularly in low site index areas or areas affected by acid deposition. Some people believe that the Forest should contribute to this green energy demand while meeting other resource needs (fuels reduction and wildlife habitat), that this will produce green jobs and wood products, and that it is better to burn the trees for fuel rather than burning them as part of prescribed burns. Other people don't believe that biomass fuels are a green source of energy, don't believe that energy should take precedence over forest health, or believe that biomass will compete with pulpwood and drive up prices.

Economics and Local Community

ISSUE STATEMENT: Management activities may affect the economic role of the Forest, particularly the role it plays in the economy of local communities, including the production of ecosystem services and commodity outputs. Increasing population and development near the Forest may influence access to the National Forest and management activities such as special use requests, fire management, and responses to additional recreation demands.

BACKGROUND: Some outputs from management activities can be readily valued, such as timber, firewood, and recreation fees. Ecosystem services are the suite of goods and services from the Forest that are vital to human health and livelihood and are traditionally viewed as free benefits to society, or "public goods", such as

wildlife habitat and diversity, watershed services, carbon storage, and scenic landscapes. These outputs and services can all be important to many of the rural communities in and around the National Forest. Several categories of activities identified as important to local communities include tourism (family-based nature activities, recreation events, all-terrain riding opportunities, equestrian and mountain bike use, wilderness, new trails), habitat management that increases diversity for wildlife viewing and game populations for hunting, and timber production that supports the logging industry.

Climate Change

ISSUE STATEMENT: Changes in climate may require adaptation strategies that facilitate the ability of ecosystems and species to adapt to changes in conditions (such as stream temperature, community vegetation composition, and invasive species). Forest management activities may exacerbate the impacts of climate change or mitigate the impacts through adding to or sequestering carbon or enhancing opportunities for alternative energy sources (wind, biomass, solar).

BACKGROUND: In developing management strategies to deal with a changing climate, it has been recognized that forests can play an important role in both mitigating and adapting to climate change. Mitigation measures focus on strategies such as carbon sequestration by natural systems, ways to increase carbon stored in wood products, ways to provide renewable energy from woody biomass to reduce fossil fuel consumption, and ways to reduce environmental footprints. Adaptation measures address ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions so that forest resources can better adapt to change. Based on current projections, the primary regional-level and state-level predicted effects of climate change that would impact the GWNF include: (1) warmer temperatures; (2) extreme weather events; and (3) increased outbreaks of insects, disease, and non-native invasive species. Comments suggested that the Plan should address reducing current threats to forest conditions, such as from non-native invasive species, pests and pathogens, acid deposition, and human uses of forest resources. Some comments identified the need to provide migration corridors, which include altitudinal gradients, for plant and animal species, especially those most vulnerable to changing climate conditions. Other comments requested that we evaluate how management activities may exacerbate, mitigate or enhance effects of a changing climate. Others identified the importance of the forest's role in carbon sequestration.

SUMMARY OF ISSUES DETERMINED TO BE INSIGNIFICANT

Water Demand

ISSUE STATEMENT: Granting requests for water withdrawals to meet increasing water needs may affect stream systems, water quality and groundwater dependent resources.

BACKGROUND: Demand for water, particularly high quality water is expected to increase in areas around the National Forest. This includes groundwater and surface water for drinking and opportunities for hydroelectric power. Many of these needs can likely be met downstream from National Forest System lands. Actual requests for access to develop drinking water sources have been very limited.

REASON FOR NON-SIGNIFICANT ISSUE: While water is becoming increasingly important in the eastern U.S., the Forest has not seen an increase in requests for water use. So this issue is of limited extent on the Forest. Provisions for addressing this issue in the future would occur through the environmental analysis that would accompany any request for a special use to allow water withdrawal.

Air Quality

ISSUE STATEMENT: Management actions, especially fire management, may affect air quality, including Class I and non-attainment areas. Air pollution from sources outside the Forest, such as ozone and acid deposition, may affect forest resources, like soil and water quality, nutrient cycling, and air pollution impacts to vegetation.

BACKGROUND: Forest resources are affected by air pollutants, such as ozone and acid deposition, from outside the Forest. Acid deposition has affected many of the Forest's sensitive watersheds and acidified streams. Some forest management activities, such as prescribed burning and wildfire management, can contribute to air pollution, particularly with fine particulates in smoke.

REASON FOR NON-SIGNIFICANT ISSUE: Impacts of management activities is partially addressed by law (Clean Air Act). The impacts of air pollution on forest resources will be addressed as management needs or current conditions. It is unlikely that alternatives will address responses to air quality in different ways, aside from different levels of activities. The effects of activities on air quality will be addressed in the analysis.

Scenery

ISSUE STATEMENT: Various management activities could affect scenic resources across the forest through changes in vegetation and road and facilities construction.

BACKGROUND: Scenery is a key resource and much of the high use that the GW receives is due to pleasing scenery.

REASON FOR NON-SIGNIFICANT ISSUE: Scenery is a key component of the Forest. It is unlikely that alternatives will address scenery in different ways. All alternatives would require that scenic integrity objectives would be met.

Geology/Karst

ISSUE STATEMENT: Management activities may affect karst areas, ground and surface water, and biodiversity associated with karst areas and caves. Management activities may affect or be affected by geologic hazards.

BACKGROUND: Karst areas are landscapes formed in areas of carbonate rocks such as limestone or dolomite. These landscapes often have caves or sinkholes and the relationship of the area to groundwater is extremely important. Geologic hazards are potentially safety concerns related to the type, structure or location of geologic features. They include landslides, rock falls, floods and abandoned mines.

REASON FOR NON-SIGNIFICANT ISSUE: In all alternatives, measures will be prescribed to protect karst resources.

Lands

ISSUE STATEMENT: The acquisition, disposition and exchange of National Forest System lands may affect access, trespass, fragmentation, and management activities.

BACKGROUND: Lands management includes acquisition of lands, exchange of federal lands for private lands, and the marking and maintenance of boundary lines.

REASON FOR NON-SIGNIFICANT ISSUE: This issue is limited in extent across the Forest and is unlikely to vary by alternative.

Grazing

ISSUE STATEMENT: Concern about impacts of grazing on water quality and inhibiting restoration of bottomland hardwoods in floodplains.

BACKGROUND: Grazing currently occurs on five areas covering about 250 acres of the Forest. Four of the areas are along the South Fork of the Shenandoah River. Grazing is used on these areas to maintain open, pastoral settings.

REASON FOR NON-SIGNIFICANT ISSUE: This issue is limited in extent on the Forest since grazing occurs on less than 1,000 acres.

User Fees

BACKGROUND: Some comments addressed the need for additional user fees on the forest or questioned why hunters and anglers were required to purchase a National Forest Stamp when other users were not required to pay a fee to enjoy their activities on the National Forest.

REASON FOR NON-SIGNIFICANT ISSUE: The issue of user fees will not be considered further in the revision effort for the following reasons. Congress passed a law (Federal Lands Recreation Enhancement Act, also referred to as REA) that provided limits on areas and sites where recreation fees can be charged. The Act prohibits certain fees for 1) general access to the national forest; 2) horseback riding, walking through, driving through, or boating through areas where no facilities or services are used; 3) access to overlooks or scenic pullouts; and 4) undesignated parking areas where no facilities are provided for; picnicking along roads or trails. The REA was signed into law December 8, 2004 and expires 10 years from that date unless renewed by the U.S. Congress.

The agency did not create the "National Forest Stamp" for hunters and anglers; the states created the laws that charge these recreationists for hunting and fishing on the National Forest.

Law Enforcement

BACKGROUND: Some comments were received regarding the need for more law enforcement activities on the National Forest.

REASON FOR NON-SIGNIFICANT ISSUE: While law enforcement is a critical part of managing the National Forests, the level of law enforcement funding and specific activities of law enforcement officers are not forest plan decisions and so are outside the scope of this analysis.

Education

BACKGROUND: Some comments were received regarding the importance of providing environmental education opportunities on the Forest.

REASON FOR NON-SIGNIFICANT ISSUE: The level of activity provided for education is not a component of the Forest Plan and is outside the scope of the analysis. While environmental education is not a plan component, it is important to highlight the need for more emphasis on environmental education and to acknowledge the tremendous opportunities that the Forest provides to meet the need to educate youth about the Forest's resources.

PLANNING PROCESS RECORDS

The Forest's Interdisciplinary Team is responsible for developing the Revised Forest Plan. Efforts were made to provide detailed explanations of each step of the revision in the form of process (or planning) records. This FEIS contains summaries of the process records and includes references to the parent records. Process records are on file in the Forest Supervisor's Office. To review these records, contact:

Forest Supervisor's Office
George Washington and Jefferson National Forests
5162 Valleypointe Parkway
Roanoke, VA 24019
(540)265-5100

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CHAPTER 2 - ALTERNATIVES

INTRODUCTION

This chapter describes the nine alternatives considered in detail in this Environmental Impact Statement. The alternatives suggest a variety of scenarios for managing the George Washington National Forest and responding to the significant issues described in Chapter 1. This chapter also explains the alternative development process, provides reasons for why some alternatives were originally considered and then later eliminated from detailed study, describes those alternatives considered in detail, and compares how each alternative responds to the significant issues.

DEVELOPMENT OF ALTERNATIVES

National Forest Management Act regulations at 36 CFR 219.12(f) state that the interdisciplinary team will formulate a broad ranges of reasonable alternatives and that the primary goal in formulating alternatives, besides complying with NEPA procedures, is to provide an adequate basis for identifying the alternative that comes nearest to maximizing net public benefits, consistent with the resource integration and management requirements of 219.13 through 219.27.

The alternative development process began with the analysis of the need for change described in the Analysis of the Management Situation. From the need for change came an alternative that was briefly described in the Notice of Intent along with the current management, or No Action alternative. The No Action alternative became Alternative A and the alternative developed from the need for change analysis became Alternative B. After the scoping period initiated with the Notice of Intent (March 2010) was completed, the Interdisciplinary Team identified the significant issues. The Interdisciplinary Team then identified alternative ways to address the issues and a range of responses to the issues. This range of responses to the issues was then put together into Alternatives C, D, E and F. A public workshop was held with the Interdisciplinary Team to discuss the alternatives and the alternatives were further refined based on those discussions. Another public workshop was held in October 2010 to address the alternatives. The Forest Leadership Team and Interdisciplinary Team then met to discuss the alternatives to find a preferred alternative. The result of that meeting, and further discussions with the Responsible Official (Regional Forester), resulted in the development of Alternative G as the preferred alternative upon which the Draft Forest Plan was designed. Alternatives H and I were developed following the analysis of comments on the Draft Forest Plan.

Public input supported a Forest Plan based on reasonable budgets so the alternatives were developed with realistic budget flexibilities and workforce capabilities in mind. All alternatives were also required to meet the purpose and need identified in Chapter 1 of the FEIS and address one or more of the significant issues.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Some comments were made that alternatives should be developed that maximize certain resources or resource management activities. Given that the purpose of this analysis is to revise a current Forest Plan that is designed to continue to meet the multiple use mandate, maximization of resources at the expense of other resources does not meet the purpose and need. However, the benchmark analyses addressed in the Analysis of the Management Situation do identify some of the potential benefits and tradeoffs from maximizing some outputs.

Some comments were also made to consider an alternative that involves no management on the Forest, to let natural processes dominate without human intervention. This alternative was not considered in detail because it could not meet the purpose and need identified in Chapter 1 and it could not meet legal requirements of the National Forest Management Act of 1976, the Multiple-Use Sustained Yield Act of 1960 and the Endangered

Species Act of 1973. However, Alternative C does consider a low level of management activities and is considered in detail.

Some comments expressed a desire to see a much higher level of timber production, in order to provide wood products and early seral conditions for wildlife. Although the Forest is capable of producing a sustained yield of a much higher level of timber production (as shown in the Maximum Timber Volume Benchmark in Appendix B), this alternative was not considered in detail, due to concerns that expected budgets could not support that level of production.

Another alternative that was proposed was to have a separate alternative that addresses the actual accomplishments achieved during the past implementation of the current plan. Since many aspects of the current plan were not achieved, this alternative would be different than Alternative A which represents the 1993 Forest Plan direction, rather than actual implementation of the Forest Plan. Rather than developing a separate alternative, the EIS does identify the places where Alternative A differs between its direction and its actual implementation.

CONSISTENCY WITH RENEWABLE RESOURCES PLANNING ACT

National Forest Management Act regulations at 36 CFR 219.12(f)(6) (1982) state that at least one alternative be developed which responds to and incorporates the Renewable Resource Planning Act (RPA) program tentative resource objectives. The Government Performance and Results Act (GPRA) of 1993 requires federal agencies to prepare strategic plans, which duplicated much of the RPA Program. The Agency no longer prepares an RPA Program but does periodically update its strategic plan that identifies goals, outcomes, performance measures, and strategies applicable to management of the National Forest System. The Agency continues to periodically update the RPA Assessment, which presents national and regional analyses of the renewable resource situation, including projections of supply and demand. However, neither the RPA Assessment nor the Forest Service Strategic Plan contains recommended output targets applicable to individual National Forests. The alternatives evaluated in this FEIS incorporate the broad, strategic objectives of the Forest Service Strategic Plan 2007-2012.

DEVELOPMENT OF MANAGEMENT AREA PRESCRIPTIONS

Developing a variety of Management Area Prescriptions with different desired conditions, suitable uses and standards to apply to distinct areas of the Forest was the primary method used to formulate a range of alternatives to address the significant issues. The management area prescriptions were largely derived from the management prescriptions used for the Jefferson Forest Plan. The same naming conventions were used and some changes were made to the desired conditions and standards. Table 2-1 lists the full set of management prescriptions allocated in the range of alternatives.

Table 2-1. Management Area Prescriptions Allocated in the Range of Alternatives

Prescription Code	Prescription Description
1A	Designated Wilderness
1B	Recommended Wilderness Study Areas
2C2	Eligible Wild and Scenic Rivers-Scenic
2C3	Eligible Wild and Scenic Rivers-Recreation
4A	Appalachian National Scenic Trail Corridor
4B1	Research Natural Areas
4C1	Geologic Areas
4D	Special Biological Areas
4D1	Key Natural Heritage Community Areas
4E	Cultural Areas
4F	Mount Pleasant National Scenic Area
4FA	Recommended National Scenic Areas
5A	Administrative Sites
5B	Communication Sites
5C	Utility Corridors
7A1	Scenic Byways
7B	Scenic Corridors and Viewsheds
7C	ATV Use Areas
7D	Concentrated Recreation Areas
7E	Dispersed Recreation Areas
7E1	Dispersed Recreation Areas-Unsuitable for Timber Production
7E2	Dispersed Recreation Areas-Suitable for Timber Production
7F	Blue Ridge Parkway Corridor
7G	Pastoral Landscapes
8A1	Mix of Successional Habitats
8A1U	Mix of Successional Habitats-Unsuitable for Timber Production
8B	Early Successional Habitats
8BU	Early Successional Habitats-Unsuitable for Timber Production
8C	Black Bear/Remote Habitats
8CU	Black Bear/Remote Habitats-Unsuitable for Timber Production
8E4a	Indiana Bat-Primary Conservation Areas
8E4b	Indiana Bat-Secondary Conservation Areas
8E7	Shenandoah Mtn Crest-Cow Knob Salamander Area
9A1	Source Water Watershed Protection Areas
10B	Timber Production Areas
10BU	Timber Production Areas-Unsuitable
11	Riparian Corridors
12D	Remote Backcountry Areas
13	Mosaics of Habitat-Suitable for Timber Production
13U	Mosaics of Habitat-Unsuitable for Timber Production

ALTERNATIVES CONSIDERED IN DETAIL

Alternative A - No Action Alternative

The 36 CFR 219.12(f)(7) 1982 regulations state that "at least one alternative shall reflect the current level of goods and services provided by the unit and the most likely amount of goods and services expected to be provided in the future if current management direction continues. Pursuant to NEPA procedures, this alternative shall be deemed the 'no action' alternative."

Alternative A represents the 1993 Forest Plan, as amended through ten amendments. In this situation, 'no action' means no change from the current management direction and it provides the baseline for the effects analysis in the EIS. While Alternative A represents the 1993 Plan, it is important to note that annual budgets affect implementation of a Forest Plan. The Analysis of the Management Situation contains a table of accomplishments during the life of the 1993 Forest Plan. In this FEIS, where annual accomplishments have varied substantially from Forest Plan direction and assumptions, the actual accomplishment level will be noted. In addition, where recent budgets have resulted in substantial departures from the plan level of activities an additional column has been added to the tables in the EIS. This column is labeled A^1 and represents the effects of the level of activities accomplished during the past three years (2009 through 2011).

The ten amendments to the 1993 Forest Plan include: Fore Mountain was added to the communication sites in Management Area 20; Laurel Fork Special Management Area was made no longer available for oil and gas leasing; Mount Pleasant was designated as a National Scenic Area; the Biological Opinion for the Indiana Bat was adopted; Jerkemtight Road was relocated and dropped as featured Off-Highway Vehicle route; and the remaining amendments were errata or clarifications. Priest and Three Ridges recommended wilderness study areas have been designated as Wilderness since 1993.

The 1993 Forest Plan provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. Maintaining biological diversity is a major goal with standards designed to conserve specific elements of biodiversity and restore others. Conservation of biodiversity is an integral part of sustaining multiple uses of the Forest.

The following are highlights of Alternative A, the 1993 Forest Plan:

ACCESS

- Road construction 3-8 miles/year (Actual road construction has averaged 1.8 miles/year).

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Streamside management zones (66' along perennial and 33' along intermittent streams).
- Municipal watersheds identified, but not highlighted; impaired streams and reservoirs not recognized.

RECREATION

- Three existing ATV/OHV Use Areas; one additional area planned at Archer Run.
- Large increase in trail construction.
- Featured OHV routes identified and managed for OHV use.
- New developed recreation sites and expansions of existing sites.
- Use of adopted ROS settings.

WILDERNESS/ROADLESS

- One Recommended Wilderness Study area remains - Saint Mary's Addition South.
- Portions of the Inventoried Roadless Areas are allocated to active management (9%), rest allocated to Remote Backcountry Areas and Special Biological Areas.
- Remote Backcountry prescriptions are not suitable for timber harvest, but do allow some salvage harvest. Road construction is generally prohibited, with limited exceptions.
- About 55% of the Potential Wilderness Areas are in remote settings.

- Since this alternative continues the 1993 Forest Plan direction for the management of the Inventoried Roadless Areas (IRAs), it is recognized that some of the management actions allowed in the IRAs would not be consistent with the 2001 Roadless Area Conservation Rule (RACR).

TIMBER HARVEST

- Timber Harvest: ASQ is 23.5 MMBF/year, annual regeneration program of 2,400 acres. Suitable acres are 350,000. Actual average regeneration program has been 629 acres/year (10 year average).
- Utilizes a management area prescription with wood products as the primary management objective.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional is based on biodiversity, wood product demand, balanced age class concerns, and desire for increased game populations.

TERRESTRIAL DIVERSITY

- Separate management area prescriptions for wildlife: early successional, remote habitat, mosaics of habitat, and small game/watchable wildlife.
- Special Biological Areas are around 90,000 acres.

OLD GROWTH

- No old growth management areas.
- Old growth is defined by Forest derived definitions.
- Allowed to harvest on suitable ground in old growth forest type for Dry-Mesic Oak.

FOREST HEALTH

- Gypsy moth is the main focus; use of Integrated Pest Management techniques.

WIND

- The Plan has no specific direction for wind development.

OIL AND GAS

- Of the 995,000 acres available for leasing, approximately 139,000 acres are available under standard lease terms, 815,000 acres are under controlled surface occupancy stipulations and 41,000 acres are under no occupancy stipulations.
- No direction is specifically related to Marcellus shale development.

ECONOMICS AND LOCAL COMMUNITY

- Mix of ecosystem services and commodity outputs.

FIRE

- Prescribed fire program is 3,000 acres/year. Actual average prescribed burning has been 4,666 acres/year.
- Use of wildfire is allowed to achieve forest goals but no criteria developed.

CLIMATE CHANGE

- No direction is specifically related to climate change.
- About 2/3 of Forest is managed to move towards late successional conditions.
- Active management of vegetation structure and composition is predominantly through timber harvest activities.
- Much of Forest is available for development of natural gas production.
- Soil and water improvement are important, but not prioritized by any specific watersheds.

Alternative B

This alternative is based on changes to the current plan identified in the Analysis of the Management Situation. The analysis was based on an IDT evaluation of the 1993 Forest Plan direction, monitoring and evaluation results, new policies, best available science and an attempt to balance public issues that were identified as of March 2010. The need to change items that were listed in the Notice of Intent in March 2010 to begin preparation of the EIS included the following: 1) Identify desired conditions and objectives to maintain the resilience and function of nine identified ecological systems, determine the desired structure and composition of those ecosystems, and incorporate management direction to provide habitat for maintaining species viability and diversity across the forest; 2) Substantially increase the objective for using prescribed fire in ecosystem restoration and incorporate the use of wildfire for resource enhancement; 3) Move the Remote Backcountry boundaries to match the Inventoried Roadless Area boundaries; 4) Portions of a few Inventoried Roadless Areas (about 8,000 acres), where the boundary of the Inventoried Roadless Areas is along existing roads and the adjacent forest has been actively managed for many years, are proposed to remain in active management rather than in Remote Backcountry; 5) The Remote Backcountry Areas would be managed with standards that are consistent with the timber harvesting and road construction restrictions of the 2001 Roadless Area Conservation Rule (RACR), with the exception that the salvage of dead and dying trees (without the use of road construction) is allowed as long as the roadless character of the area is maintained.

The following are highlights of Alternative B:

ACCESS

- No net increase in open road miles.
- Road construction of about 1.5 mile per year.
- Road decommissioning 16 miles/year for the first decade. An additional 2 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas defined the same as on the Jefferson NF (100' on perennial, 50' on intermittent streams) in all watersheds.
- Drinking water supplies identified. Drinking water watersheds and watersheds above impaired streams and reservoirs negatively affected by acid deposition are a priority for restoration.

RECREATION

- Three existing ATV/OHV Use Areas; drop planned Archer Run area.
- No net increase in trail miles or maintenance (can increase but would also have to decommission).
- There are no specific roads featured for licensed OHV use but miles would stay at current level.
- No new developed recreation sites; few expansions of existing sites.
- Semi-primitive areas outside of Wilderness, Recommended Wilderness Study Areas or Remote Backcountry Areas do not have limitations on road construction.

WILDERNESS/ROADLESS

- Recommend Saint Mary's Addition West, Little River, Rich Hole addition, and Ramsey's Draft addition (total 20,000 acres) for Wilderness Study Areas.
- Portions of the Inventoried Roadless Areas are allocated to active management (4%), rest allocated to Remote Backcountry or Special Biological Areas. However, it is recognized that under this alternative, the portions of the IRAs that are allocated to active management may have management activities that would not be consistent with the 2001 Roadless Area Conservation Rule (RACR).
- The Remote Backcountry Areas are generally managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR. However, under this alternative there would be an exception to allow for salvage harvests (which for those areas that are also in IRAs, this exception would not be consistent with the 2001 RACR).
- Most of the additional Potential Wilderness Areas in current active management would remain in active management.

TIMBER HARVEST

- The ASQ is around 27.9 MMBF/year, annual regeneration program of 1,800-3,000 acres. Suitable acres are 486,000.
- Primary purpose of timber harvest is to support other resource objectives.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional habitat is based primarily on ecological objectives and restoration objectives.

TERRESTRIAL DIVERSITY

- One broad management area prescription for wildlife habitat emphasis.
- About 118,000 acres of Special Biological Areas.

OLD GROWTH

- No old growth management areas. Old growth is defined by Regional definitions.
- Most of the stands meeting the old growth definition are unsuitable for timber production. Areas in the most common forest type (Dry-Mesic Oak Forests) that are on lands suitable for timber production could be considered for harvest.

FOREST HEALTH

- Increased recognition of non-native invasive species; use of Integrated Pest Management techniques.

WIND

- Areas not suitable for wind development: Wilderness, Recommended Wilderness Study Areas, Eligible Scenic River Corridors, Eligible Recreation River Corridors, Appalachian Trail Corridor, Research Natural Areas, Geologic Areas, Mount Pleasant National Scenic Area, Special Biological Areas, Developed Recreation Areas, Blue Ridge Parkway Corridor, Shenandoah Mountain Crest-Cow Knob Salamander Area, Indiana Bat Protection Areas, and Remote Backcountry Areas.

OIL AND GAS

- Of the 983,000 acres available for leasing, approximately 615,000 acres are available under standard lease terms, 152,000 acres are under controlled surface occupancy stipulations and 202,000 acres are under no occupancy stipulations and 14,000 are under a timing stipulation.
- Horizontal drilling (Marcellus shale development) is allowed on all available acres but specific standards related to hydraulic fracturing would be used.

ECONOMICS AND LOCAL COMMUNITY

- Similar to Alternative A.

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year.
- Utilize fire to attain ecological objectives for biodiversity when appropriate.

CLIMATE CHANGE

- Impaired streams and reservoirs are priority for restoration; actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR species).
- Timber harvest, fire, and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

Alternative C

In this alternative, restoration and maintenance of sustainable ecological systems is accomplished predominantly through natural processes, with little human intervention. It also addresses the need for non-motorized recreation opportunities. This alternative emphasizes low-impact activities and passive restoration of natural communities at a slow rate. Active management is for the protection of Forest resources and meeting legal requirements, with limited exceptions. Recreation emphasis is on semi-primitive settings and opportunities. This alternative features the most area Recommended for Wilderness Study. The character will be of a landscape evolving through successional stages toward a natural-evolving appearance. This alternative also emphasizes linking together movement corridors and large undisturbed areas for forest interior species and late-successional species. Effects of native insects and diseases are accepted but non-native species are controlled. Road network mileage is reduced through closure or decommissioning of roads not needed for ecosystem stewardship, restoration or dispersed recreation use. Many of the closed roads are used to supplement the trail system for non-motorized uses.

This alternative does not allow any new federal oil and gas leasing. The approximately 10,200 acres (or 1 percent of the GWNF) of mineral rights that are under current federal oil and gas leases will continue to be legally available for federal oil and gas leasing. The approximately 167,200 acres (or 16 percent of the GWNF) of mineral rights that are owned by private parties (also called outstanding or reserved) are constitutionally protected property rights.

The following are highlights of Alternative C:

ACCESS
- Extensive road closure or decommissioning; but some access is still needed for non-motorized activities.
- No road construction.
- Road decommissioning 16 miles/year for first decade. An additional 147 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY
- Riparian areas are the same as on Jefferson NF (100' on perennial, 50' on intermittent streams) but buffers are larger in source drinking watersheds and along impaired streams.
- Drinking water watersheds are allocated to a management area prescription where these management areas and watersheds above impaired streams and reservoirs are a priority for restoration and include management activity restrictions.

RECREATION
- Three existing ATV/OHV Use Areas; drop planned Archer Run area.
- Increase in trails for non-motorized users but no net increase in maintenance (by relocating or decommissioning unsustainable trails).
- No management of roads for OHV use.
- No new developed recreation sites, closure of some sites.
- Maintain inventoried semi-primitive acres and move towards a primitive ROS setting in the Shenandoah Mountain area.

WILDERNESS/ROADLESS
- High level of Recommended Wilderness Study Areas (380,000 acres), including all of the Potential Wilderness Areas.
- Remote Backcountry Areas will be managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR.

TIMBER HARVEST
- No ASQ or suitable land base.
- No commercial timber program but incidental harvest may occur.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Creation of early successional habitat through harvest of trees is very limited, only for threatened and endangered species and limited sensitive species habitat.

TERRESTRIAL DIVERSITY

- No management area is defined for wildlife or timber since most of the forest will provide for forest interior species and late-successional species; emphasis is to minimize fragmentation and edge effects.
- About 118,000 ac of Special Biological Areas plus about 17,000 acres for wood turtle habitat.

OLD GROWTH

- No old growth management areas. Old growth is defined by Regional definitions.
- No harvest of any stands meeting the definition of old growth forest.

FOREST HEALTH

- Heavy emphasis on prevention of the introduction and minimizing the spread of non-native invasive species, especially in remote settings. Increased emphasis on non-motorized recreation may require aggressive prevention measures in concentrated use areas. Limited use of herbicides and insecticides.

WIND

- No wind development allowed.

OIL AND GAS

- The approximately 167,200 acres (or 16% of the GWNF) of mineral rights that are owned by private parties (also called outstanding or reserved mineral rights) are constitutionally protected property rights and would not be affected by implementation of this alternative.
- The approximately 10,200 acres (or 1 percent of the GWNF) of mineral rights that are under current federal oil and gas leases would not be affected by implementation of this alternative.
- The approximately 51,000 acres (or 5% of the GWNF) that are congressionally withdrawn from mineral entry (i.e. Wilderness, and Mount Pleasant Scenic Area) would continue to be legally unavailable for federal oil and gas leasing.
- All other areas would be administratively unavailable for federal oil and gas leasing.

ECONOMICS AND LOCAL COMMUNITY

- Fewer commodity outputs, focus is on remote non-motorized recreation and ecosystem services outputs.

FIRE

- Very limited use of prescribed fire, primarily for TES species.
- Allow wildfires to burn as much as possible.

CLIMATE CHANGE

- Passive restoration through natural processes; manage most of the forest to move towards late successional conditions.
- Reduce access to the forest to limit introduction and spread of invasives.
- Decommissioning of roads to reduce potential sedimentation in streams.
- Less fragmentation to increase connectivity of migration corridors for species that rely on mature, closed canopy forests.

Alternative D

In this alternative, restoration and maintenance of natural ecological systems uses practices that also produce a higher level of commodities and offers amenities that enhance tourism for local communities that benefit economically from forest visitors and forest products. This alternative has the highest level of timber production. A mixture of timber outputs is focused on species/product combinations with strong demand. Mineral leasing decisions respond to public need and maximize benefits to local communities. Mitigation measures for the effects of climate change are met through providing opportunities for alternative energy, such as wind power, natural gas, timber and wood biomass energy. Public access (travelways, use corridors, waterways, and trails - including off-highway vehicles) are increased in high-use areas and/or improved to provide for more opportunities for recreation and other forest uses to occur when compatible with other resources. Additional roads may be needed to support the production of wood products and natural gas development. Roads are still analyzed for decommissioning but opportunities for using unneeded roads for trail access are preferable. Habitats are provided for game species, species with high public interest, species with demanding habitat requirements, species that are ecological indicators and keystone species. Management direction supports special use requests for facilities or developments that enhance economic development for local communities, such as communications towers or non-commercial wind towers. This alternative responds to public desires for more accessibility to National Forest System lands.

The following are highlights of Alternative D:

ACCESS

- Some road construction to support tourism opportunities and commodity production.
- Road construction about 4 miles/year; road decommissioning 8 miles/year. An additional 6 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian areas same as on Jefferson NF (100' on perennial, 50' on intermittent streams) in watersheds with threatened and endangered aquatic species. Current plan standards apply in the rest of the forest.
- Drinking water watersheds identified per State designation are a priority for restoration activities, along with watersheds above impaired streams and reservoirs.

RECREATION

- Three existing ATV/OHV Use Areas; more than one new area could be planned.
- Increase in trails for tourism, such as long distance, connected trails for user events.
- Featured OHV routes are identified and managed for OHV use.
- No new developed recreation sites but offer more amenities at existing sites.
- Semi-primitive areas outside Wilderness, Recommended Wilderness Study Areas or Remote Backcountry Areas do not have limitations on road construction.

WILDERNESS/ROADLESS

- Low level of Recommended Wilderness Study Areas (14,000 acres), determined by additions to existing Wilderness, areas with unique visitor draws, and Rockbridge Co. Board of Supervisors recommended areas.
- Portions of the Inventoried Roadless Areas are allocated to active management, rest allocated to Remote Backcountry or Special Biological Areas. However, it is recognized that under this alternative, the portions of the IRAs that are allocated to active management may have management activities that would not be consistent with the 2001 RACR. Most of the additional Potential Wilderness Areas in current active management remain in active management.
- The Remote Backcountry Areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR. However, under this alternative there would be and exception to allow for salvage harvest (which would not be consistent with the 2001 RACR).

TIMBER HARVEST

- ASQ around 52.9 MMBF/year. Annual regeneration program of 3,000-5,000 acres. Suitable acres are 482,000.
- Utilize a management area prescription with timber as the primary management objective.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional is based on wood product demand, balanced age class concerns, increased game populations, and restoration objectives.

TERRESTRIAL DIVERSITY

- Separate management area prescriptions for wildlife: early successional, remote habitat, mosaics of habitat, small game/watchable wildlife; perhaps add one specifically for grouse.
- About 118,000 acres of Special Biological Areas.

OLD GROWTH

- No old growth management areas. Old growth is defined by Regional definitions.
- Most of the stands meeting the old growth definition are unsuitable for timber production. Areas in the most common forest types (Dry-Mesic Oak Forests and Dry and Dry-Mesic Oak-Pine Forests) that are on lands suitable for timber production could be considered for harvest.

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas.

WIND

- Wind development is suitable across much of the forest where there is a high potential for wind development; several Inventoried Roadless Areas would also be available for wind development; however, it is recognized that any road construction needed to support wind development would not be consistent with the 2001 RACR.

OIL AND GAS

- Of the 981,000 acres available for leasing, approximately 609,000 acres are available under standard lease terms, 157,000 acres are under controlled surface occupancy stipulations, 201,000 acres are under no occupancy stipulations and 14,000 acres are under a timing stipulation.
- Horizontal drilling (Marcellus shale development) is allowed on all available acres but specific standards related to hydraulic fracturing would be used.

ECONOMICS AND LOCAL COMMUNITY

- Increase in commodity outputs related to wood, minerals. Also emphasize alternative energy and tourism, including motorized recreation.

FIRE

- Use prescribed fire on unsuitable acres and timber management on suitable acres to achieve ecological objectives; prescribed fire program between 5,000 and 12,000 acres/year.
- Utilize fire to attain ecological objectives for biodiversity when appropriate, but minimize burning of lands suitable for timber production.

CLIMATE CHANGE

- Increase opportunities for climate change mitigation (alternative energy sources such as wind, oil and gas leasing and Marcellus Shale development).
- Source drinking watersheds and impaired waters are priority for restoration.
- Actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR species). Timber harvest, fire, and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

Alternative E

Alternative E actively restores and maintains vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Prescribed fire, timber harvest and maintenance of grasslands and shrublands are all used to provide a diverse mix of habitats in the ecological systems. In some areas of the forest large blocks of mature forest predominate. Alt E emphasizes improving soil and water concerns in high priority watersheds. As a result of restoration treatments, commodities such as sawlogs, wood biomass energy, and fuelwood are available for local industry and individual needs. Restoration activities such as prescribed fire and thinning are more intensive than in the other alternatives. A variety of recreation settings occur in areas compatible with restoration activities. New recreation developments are limited; the emphasis is on maintaining existing developments.

The following are highlights of Alternative E:

ACCESS

- No net increase in open road miles.
- Road construction is 1 mile/year.
- Road decommissioning is 16 miles/year. An additional 4 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as on Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds.
- Priority watersheds are identified based on water use (sensitive aquatic species, drinking water), impairment (particularly acid deposition), and sensitivity are a priority for restoration activities.

RECREATION

- Three existing ATV/OHV Use Areas; drop planned Archer Run area.
- No net increase in trail miles or maintenance, focus on relocating or decommissioning of unsustainable trails.
- No management of roads for OHV use.
- No new developed recreation sites, closure of some sites located in floodplains.
- Maintain inventoried semi-primitive acres.

WILDERNESS/ROADLESS

- Recommended Wilderness Study Areas (24,000 acres) include Little River and additions to Rich Hole, Rough Mountain, Ramsey's Draft, Saint Mary's, and Three Ridges.
- Portions of the Inventoried Roadless Areas are allocated to active management, rest allocated to Remote Backcountry and Special Biological Areas. However, it is recognized that under this alternative, the portions of the IRAs that are allocated to active management may have management activities that would not be consistent with the 2001 Roadless Area Conservation Rule (RACR). Most of the additional Potential Wilderness Areas in current active management would remain in active management.
- The Remote Backcountry Areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR.

TIMBER HARVEST

- ASQ around 15.5 MMBF/year, annual regeneration program of 1,800-3,000 acres. Suitable acres are 366,000.
- Primary purpose of timber harvest is to support other resource objectives.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional is based on ecological objectives, and restoration objectives.

TERRESTRIAL DIVERSITY

- One broad management area prescription for wildlife habitat emphasis.
- About 118,000 acres of Special Biological Areas.

OLD GROWTH

- No old growth management areas. Old growth is defined by Regional definitions.
- Stands meeting the definition of old growth forests are not suitable for timber production, but trees in these stands can be cut to actively restore structural conditions.
- The Peters Mountain and Frozen Head areas (with boundaries modified from the Virginia DCR proposal) are unsuitable for timber production.

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas.

WIND

- No wind development allowed.

OIL AND GAS

- Of the 980,000 acres available for leasing, approximately 535,000 acres are available under standard lease terms, 160,000 acres are under controlled surface occupancy stipulations, 271,000 acres are under no occupancy stipulations and 14,000 acres are under a timing stipulation.
- No areas are available for horizontal drilling (Marcellus shale development).

ECONOMICS AND LOCAL COMMUNITY

- Focus is on outputs of ecosystem services, but this results in some increase in timber commodity outputs.

FIRE

- Prescribed fire program around 20,000 acres/year based on ecological objectives.
- Favor use of wildfire to achieve ecological objectives instead of aggressive suppression.

CLIMATE CHANGE

- Increase activities to adapt to climate change (improve ecosystem resiliency, restore vegetation composition and structure, aggressive treatment of invasive species).
- Source drinking watersheds and impaired waters are priority for restoration.
- Relocation or closure of some recreation sites in floodplains.
- A factor to consider in amount of Recommended Wilderness Study Areas is the desire for future flexibility.
- Actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR spp).
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

Alternative F

This alternative restores and maintains the native ecological systems while also creating many opportunities for a variety of recreation settings. The emphasis is on recreation opportunities, scenery management, and wilderness designation, while focusing ecosystem health activities in support of wildlife-based recreation. Resource management is designed to attract recreation users, both locally and from large population centers near the forest. A variety of recreation settings and experiences, both motorized and non-motorized are provided. Developed recreation facilities support dispersed recreation by providing access to water-based recreation, trailheads, cultural resource interpretation, and horse staging areas. In addition to open roads available for use, specific off-highway vehicle routes are featured. Large blocks of unroaded areas provide remote backcountry experiences not available on private lands. Habitat for early successional species is maintained in a manner that would be unnoticeable to most forest visitors. High scenic quality is a major emphasis. Active resource management is concentrated in certain locations and supports recreation use and visual quality.

The following are highlights of Alternative F:

ACCESS

- No net increase in open road miles.
- Road construction 0.5 miles/year.
- Road decommissioning 16 miles/year. An additional 26 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as on Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds.
- Drinking water watersheds identified per State designation are a priority for restoration activities, along with watersheds above impaired streams and reservoirs.

RECREATION

- Three existing ATV/OHV Use Areas; trails would be expanded in these areas; drop planned Archer Run area.
- Increase in trails for all users but no net increase in maintenance (by relocating or decommissioning unsustainable trails).
- Specific roads not featured for OHV routes but miles would stay at current level.
- No new developed recreation sites; few expansions of existing sites.
- Maintain inventoried semi-primitive acres.

WILDERNESS/ROADLESS

- High amount of Recommended Wilderness Study Areas (113,000 acres) include Beech Lick, Three High Heads, Laurel Fork, Little Alleghany, Little River, Oliver Mountain, Potts Mountain, Three Sisters, Whites Peak and additions to Rich Hole, Rough Mountain, Ramsey's Draft, Saint Mary's, and Three Ridges.
- Incorporate Shenandoah Mountain Proposal including both National Scenic Areas and wilderness area recommendations.
- All of the Inventoried Roadless Areas would be Recommended Wilderness Study Areas, Remote Backcountry or Special Biological Areas. Some of the additional Potential Wilderness Areas in current active management would remain in active management.
- The Remote Backcountry Areas would be managed with timber harvest and road construction restrictions that are consistent with the 2001 Roadless Area Conservation Rule (RACR).

TIMBER HARVEST

- ASQ around 9.6 MMBF/year, annual regeneration program of 1,000-1,800 acres. Suitable acres are 278,000.
- Primary purpose of timber harvest is to support other resource objectives.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional based on wildlife needs, ecological objectives, and restoration objectives.

TERRESTRIAL DIVERSITY

- One broad management area prescription for wildlife habitat emphasis.
- About 118,000 acres of Special Biological Areas.

OLD GROWTH

- Old growth would be allocated to a management prescription for old growth. Old growth defined by Regional definitions.
- No harvest of any stands meeting the definition of old growth forest.
- The Peters Mountain and Frozen Head areas (boundaries as identified by the Virginia DCR proposal) are unsuitable for timber production.

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas.

WIND

- Areas not suitable for wind development: Wilderness, Recommended Wilderness Study Areas, Eligible Scenic River Corridors, Eligible Recreation River Corridors, Appalachian Trail Corridor, Research Natural Areas, Geologic Areas, Mount Pleasant National Scenic Area, Special Biological Areas, Developed Recreation Areas, Blue Ridge Parkway Corridor, Shenandoah Mountain Crest-Cow Knob Salamander Area, Indiana Bat Protection Areas, and Remote Backcountry Areas.

OIL AND GAS

- Of the 763,000 acres available for leasing, approximately 495,000 acres are available under standard lease terms, 105,000 acres are under controlled surface occupancy stipulations, 149,000 acres are under no occupancy stipulations and 14,000 acres are under a timing stipulation.
- Horizontal drilling (Marcellus shale development) is allowed on all available acres (except within public water supplies) but specific standards related to hydraulic fracturing would be used.

ECONOMICS AND LOCAL COMMUNITY

- Similar to Alternative A.

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year.
- Utilize fire to attain ecological objectives for biodiversity when appropriate.

CLIMATE CHANGE

- Source drinking watersheds and impaired waters are priority for restoration.
- Actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR spp).
- Timber harvest, fire, and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

Alternative G

Alternative G was developed after reviewing public comments and agency concerns identified throughout the process leading up to the development of the Draft EIS. It was identified as the Preferred Alternative in the Draft EIS. Each significant issue was reviewed in relation to how it was addressed by the various alternatives, the environmental effects of the alternative in relation to the issue, and the benefits or outputs related to the issue. This alternative contains aspects of each of the other alternatives.

This alternative provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. It actively restores and maintains vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Habitats are provided for game species, species with high public interest, species with demanding habitat requirement, species that are ecological indicators and keystone species. It substantially increases the objective for using prescribed fire in ecosystem restoration and incorporates the use of wildfire for resource enhancement. Prescribed fire, timber harvest and maintenance of grasslands and shrublands are used to provide a diverse mix of habitats in the ecological systems. In some areas of the forest large blocks of mature forest predominate. Restoration treatments focus on increasing structural diversity in ecological systems and on improving soil and water concerns in high priority watersheds. As a result of restoration treatments, commodities such as sawlogs, wood biomass energy, and fuelwood are available for local industry and individual needs.

Road network mileage is reduced through closure or decommissioning of roads not needed for ecosystem stewardship, restoration or dispersed recreation use. Many of the closed roads are used to supplement the trail system for non-motorized uses. All of the Inventoried Roadless Areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 Roadless Area Conservation Rule (RACR).

Resource management is designed to attract recreation users, both locally and from large population centers near the forest. A variety of recreation settings and experiences, both motorized and non-motorized is provided. Large blocks of unroaded areas provide remote, backcountry experiences not available on private lands. High scenic quality is a major emphasis.

The following are highlights of Alternative G:

ACCESS
- No net increase in open road miles.
- Road construction 1.5 miles/year.
- Decommissioning 16 miles/year. An additional 2 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY
- Riparian Areas same as on Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds.
- Priority watersheds identified based on sensitive aquatic species, drinking water use identified by state agencies, impairment identified by state agencies that can be addressed by management activities on the Forest are a priority for restoration activities.

RECREATION
- Three existing ATV/OHV Use Areas; possible expansion of existing areas to provide stacked loops based on difficulty level and single track riding opportunities; drop planned Archer Run area.
- No net increase in trail maintenance, focus on relocating or decommissioning unsustainable trails, decommissioning low use trails, adding stacked loops within existing trail systems, providing connectors between existing trails, and, if feasible, providing trailheads near population centers and/or major road routes.
- High clearance roads remain available for OHV use at current levels.

- No new developed recreation sites, few expansions at existing sites.
- Maintain most of the inventoried semi-primitive acres.

WILDERNESS/ROADLESS
- Recommend Saint Mary's Addition West, Little River, Rich Hole addition and Ramsey's Draft addition (total 20,000 ac) for Wilderness Study Areas.
- All Inventoried Roadless Areas not Recommended for Wilderness Study or Special Biological Areas are allocated to Remote Backcountry and managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR.
- Areas in Potential Wilderness Areas (and not in Inventoried Roadless Areas) are allocated to a variety of management prescription areas including Remote Backcountry and Mosaics of Wildlife Habitat.

TIMBER HARVEST
- ASQ around 27.6 MMBF/year, annual regeneration program of 1,800-3,000 acres. Suitable acres are 439,000.
- Primary purpose of timber harvest is to support other resource objectives with a secondary purpose of providing wood products.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE
- Amount and location of early successional is based on ecological objectives, and restoration needs.

TERRESTRIAL DIVERSITY
- One broad management area prescription for wildlife habitat emphasis.
- About 118,000 acres of Special Biological Areas.

OLD GROWTH
- No old growth management area. Old growth is defined by Regional definitions.
- Most of the stands meeting the old growth definition are unsuitable for timber production. Areas in the common forest types (Dry-Mesic Oak Forests and Dry & Dry-Mesic Oak-Pine Forests) that are on lands suitable for timber production could be considered for harvest.
- The Peters Mountain and Frozen Head areas (boundaries modified from the Virginia DCR proposal) are unsuitable for timber production.

FOREST HEALTH
- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas.

WIND
- Areas not suitable for wind development: Wilderness, Recommended Wilderness Study Areas, Eligible Scenic River Corridors, Eligible Recreation River Corridors, Appalachian Trail Corridor, Research Natural Areas, Geologic Areas, Mount Pleasant National Scenic Area, Special Biological Areas, Developed Recreation Areas, Blue Ridge Parkway Corridor, Shenandoah Mountain Crest-Cow Knob Salamander Area, Indiana Bat Protection Areas, and Remote Backcountry Areas.

OIL AND GAS
- Of the 983,000 acres available for leasing, approximately 550,000 acres are available under standard lease terms, 161,000 acres are under controlled surface occupancy stipulations, 259,000 acres are under no occupancy stipulations and 14,000 acres are under a timing stipulation.
- No areas are available for horizontal drilling (Marcellus shale development).

ECONOMICS AND LOCAL COMMUNITY
- Focus is on outputs of ecosystem services, but this results in some increase in timber commodity outputs.

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year.
- Utilize wildfire to attain ecological objectives for biodiversity when appropriate.

CLIMATE CHANGE

- Increase activities to adapt to climate change (improve ecosystem resiliency, restore vegetation composition and structure, aggressive treatment of invasives).
- Source drinking watersheds and impaired waters are a priority for restoration.
- A factor to consider in amount of recommended wilderness study areas is the desire for future flexibility.
- Actively restore (chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR spp).
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

Alternative H

Alternative H was developed after reviewing public comments received after release of the Draft EIS. It is based on Alternative G with changes made in response to the comments and new information.

This alternative provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. It actively restores and maintains vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Habitats are provided for game species, species with high public interest, species with demanding habitat requirements, species that are ecological indicators and keystone species. It substantially increases the objective for using prescribed fire in ecosystem restoration and allows wildfire to achieve ecological objectives for resource enhancement when appropriate. Prescribed fire, timber harvest and maintenance of grasslands and shrublands are all used to provide a diverse mix of habitats in the ecological systems. In some areas of the forest large blocks of mature forest predominate. Restoration treatments focus on increasing structural diversity in ecological systems and on improving soil and water concerns in high priority watersheds. As a result of restoration treatments, commodities such as sawlogs, wood biomass energy, and fuelwood are available for local industry and individual needs.

Road network mileage is reduced through closure or decommissioning of roads not needed for ecosystem stewardship, restoration or dispersed recreation use. Many of the closed roads are used to supplement the trail system for non-motorized uses. All of the Inventoried Roadless Areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 Roadless Area Conservation Rule (RACR).

Resource management is designed to attract recreation users, both locally and from large population centers near the forest. A variety of recreation settings and experiences, both motorized and non-motorized is provided. Large blocks of unroaded areas provide remote, backcountry experiences not available on private lands. High scenic quality is a major emphasis.

The following are highlights of Alternative H:

ACCESS

- No net increase in open road miles.
- Road construction 1.5 miles/year.
- Decommissioning 16 miles/year. An additional 4 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as on Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds.
- Priority watersheds that are identified based on sensitive aquatic species, drinking water use identified by state agencies, and impairment identified by state agencies that can be addressed by management activities on the Forest are a priority for restoration activities.

RECREATION

- Three existing ATV/OHV Use Areas; possible expansion of existing areas to provide stacked loops based on difficulty level and single track riding opportunities; drop planned Archer Run area.
- No net increase in trail maintenance, focus on relocating or decommissioning unsustainable trails, decommissioning low use trails, adding stacked loops within existing trail systems, providing connectors between existing trails, and, if feasible, providing trailheads near population centers and/or major road routes.
- High clearance roads remain available for OHV use at current levels.
- No new developed recreation sites, few expansions at existing sites.
- Maintain most of the inventoried semi-primitive acres.

WILDERNESS/ROADLESS/NATIONAL SCENIC AREAS

- Recommend Saint Mary's Addition West, Little River, Rich Hole Addition, Ramsey's Draft Addition, Rough Mountain Addition and Beech Lick Knob (total 27,200 acres) for Wilderness Study Areas.
- Recommend the Shenandoah Mountain National Scenic Area (67,500 acres, this acreage is exclusive of any Recommended Wilderness Study Areas within its boundaries).
- All Inventoried Roadless Areas not Recommended for Wilderness Study or Special Biological Areas are allocated to Remote Backcountry. All of the areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR.
- Areas in Potential Wilderness Areas (and not in Inventoried Roadless Areas) are allocated to a variety of management prescription areas including Remote Backcountry and Mosaics of Wildlife Habitat.

TIMBER HARVEST

- ASQ around 27.6 MMBF/year, annual regeneration program of 1,800-3,000 acres. Suitable acres are 452,000.
- Primary purpose of timber harvest is to support other resource objectives with a secondary purpose of providing wood products.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional is based on ecological objectives, and restoration needs.

TERRESTRIAL DIVERSITY

- One broad management area prescription for wildlife habitat emphasis.
- About 121,000 acres of Special Biological Areas.

OLD GROWTH

- No old growth management area prescription areas. Old growth defined by Regional definitions.
- Most of the stands with old growth forest types meeting the old growth definition are unsuitable for timber production. Areas in the common forest types (Dry-Mesic Oak Forests and Dry & Dry-Mesic Oak-Pine Forests) that are on lands suitable for timber production could be considered for harvest.
- The Peters Mountain and Frozen Head areas (boundaries modified from the Virginia Department of Conservation and Recreation proposal) are identified as Key Natural Heritage Communities and are unsuitable for timber production.

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas.

WIND

- Areas not suitable for wind development: Wilderness, Recommended Wilderness Study Areas, Eligible Scenic River Corridors, Eligible Recreation River Corridors, Appalachian Trail Corridor, Research Natural Area, Special Geologic Areas, Special Biological Areas, Key Natural Heritage Community Areas, Mount Pleasant National Scenic Area, Shenandoah Mountain Recommended National Scenic Area, Scenic Corridors and Viewsheds, Developed Recreation Areas, Blue Ridge Parkway Scenic Corridor, Shenandoah Mountain Crest-Cow Knob Salamander Area, Indiana Bat Protection Areas, Remote Backcountry Areas.

OIL AND GAS

- Approximately 461,000 acres are available for leasing: 236,000 under standard stipulations, 88,000 acres under controlled surface use stipulations and 137,000 under no surface occupancy stipulations. Approximately 128,000 acres are administratively unavailable for leasing (Recommended Wilderness Study, Recommended National Scenic Area, Laurel Fork, Indiana Bat-Primary Area, and Public Water Supply Watersheds (and the watershed upstream of the Dry River PWS) and 51,000 are legally unavailable for leasing (Wilderness and National Scenic Area). The remaining acres have low to no

potential for Marcellus shale so a leasing decision would be made later if there was expressed interest in those areas.
- Horizontal drilling (Marcellus shale development through high volume hydraulic fracturing) is allowed on certain portions of the Forest under strict conditions.

ECONOMICS AND LOCAL COMMUNITY
- Focus is on outputs of ecosystem services, but this results in some increase in timber commodity outputs.

FIRE
- Prescribed fire program between 12,000 and 20,000 acres/year.
- Allow wildfire to attain ecological objectives for biodiversity when appropriate.

CLIMATE CHANGE
- Increase activities to adapt to climate change (improve ecosystem resiliency, restore vegetation composition and structure, aggressive treatment of invasives).
- Source drinking watersheds and impaired waters are a priority for restoration.
- A factor to consider in amount of recommended wilderness areas is the desire for future flexibility.
- Actively restore chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR species.
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

Alternative I – Selected Alternative

Alternative I was developed after reviewing public comments and new information received after release of the Draft EIS. Alternative I is the same as Alternative H except for the oil and gas leasing availability component. With respect to the availability of lands for federal oil and gas leasing, Alternative I uses the approach for administrative availability of Alternative C where no areas are available for federal oil and gas leasing, except Alternative I makes the lands with existing leases available after the current leases expire. Existing leases (approximately 10,200 acres) and private mineral rights (approximately 167,200 acres) will not be affected by this decision.

This alternative provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. It actively restores and maintains vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Habitats are provided for game species, species with high public interest, species with demanding habitat requirements, species that are ecological indicators and keystone species. It substantially increases the objective for using prescribed fire in ecosystem restoration and allows wildfire to achieve ecological objectives for resource enhancement when appropriate. Prescribed fire, timber harvest and maintenance of grasslands and shrublands are all used to provide a diverse mix of habitats in the ecological systems. In some areas of the forest large blocks of mature forest predominate. Restoration treatments focus on increasing structural diversity in ecological systems and on improving soil and water concerns in high priority watersheds. As a result of restoration treatments, commodities such as sawlogs, wood biomass energy, and fuelwood are available for local industry and individual needs.

Road network mileage is reduced through closure or decommissioning of roads not needed for ecosystem stewardship, restoration or dispersed recreation use. Many of the closed roads are used to supplement the trail system for non-motorized uses. All of the Inventoried Roadless Areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 Roadless Area Conservation Rule (RACR).

Resource management is designed to attract recreation users, both locally and from large population centers near the forest. A variety of recreation settings and experiences, both motorized and non-motorized is provided. Large blocks of unroaded areas provide remote, backcountry experiences not available on private lands. High scenic quality is a major emphasis.

The following are highlights of Alternative I:

ACCESS

- No net increase in open road miles.
- Road construction 1.5 miles/year.
- Decommissioning 16 miles/year. An additional 4 miles of road would be decommissioned if all Recommended Wilderness Study Areas become designated by Congress.

WATER, SOILS, RIPARIAN, AQUATIC DIVERSITY

- Riparian Areas same as on Jefferson (100' on perennial, 50' on intermittent streams) in all watersheds.
- Priority watersheds that are identified based on sensitive aquatic species, drinking water use identified by state agencies, and impairment identified by state agencies that can be addressed by management activities on the Forest are a priority for restoration activities.

RECREATION

- Three existing ATV/OHV Use Areas; possible expansion of existing areas to provide stacked loops based on difficulty level and single track riding opportunities; drop planned Archer Run area.
- No net increase in trail maintenance, focus on relocating or decommissioning unsustainable trails, decommissioning low use trails, adding stacked loops within existing trail systems, providing connectors between existing trails, and, if feasible, providing trailheads near population centers and/or major road routes.

- High clearance roads remain available for OHV use at current levels.
- No new developed recreation sites, few expansions at existing sites.
- Maintain most of the inventoried semi-primitive acres.

WILDERNESS/ROADLESS/NATIONAL SCENIC AREAS

- Recommend Saint Mary's Addition West, Little River, Rich Hole Addition, Ramsey's Draft Addition, Rough Mountain Addition and Beech Lick Knob (total 27,200 acres) for Wilderness Study Areas.
- Recommend the Shenandoah Mountain National Scenic Area (67,500 acres, this acreage is exclusive of any Recommended Wilderness Study Areas within its boundaries).
- All Inventoried Roadless Areas not Recommended for Wilderness Study or Special Biological Areas are allocated to Remote Backcountry. All of the areas are managed with timber harvest and road construction restrictions that are consistent with the 2001 RACR.
- Areas in Potential Wilderness Areas (and not in Inventoried Roadless Areas) are allocated to a variety of management prescription areas including Remote Backcountry and Mosaics of Wildlife Habitat.

TIMBER HARVEST

- ASQ around 27.6 MMBF/year, annual regeneration program of 1,800-3,000 acres. Suitable acres are 452,000.
- Primary purpose of timber harvest is to support other resource objectives with a secondary purpose of providing wood products.

TIMBER HARVEST, TERRESTRIAL DIVERSITY, FIRE

- Amount and location of early successional is based on ecological objectives, and restoration needs.

TERRESTRIAL DIVERSITY

- One broad management area prescription for wildlife habitat emphasis.
- About 121,000 acres of Special Biological Areas.

OLD GROWTH

- No old growth management area prescription areas. Old growth defined by Regional definitions.
- Most of the stands with old growth forest types meeting the old growth definition are unsuitable for timber production. Areas in the common forest types (Dry-Mesic Oak Forests and Dry & Dry-Mesic Oak-Pine Forests) that are on lands suitable for timber production could be considered for harvest.
- The Peters Mountain and Frozen Head areas (boundaries modified from the Virginia Department of Conservation and Recreation proposal) are identified as Key Natural Heritage Communities and are unsuitable for timber production.

FOREST HEALTH

- Aggressive treatment of non-native invasive species; use of Integrated Pest Management techniques; emphasis on minimizing spread to adjacent private lands; aggressive prevention and control in disturbed areas or high use areas.

WIND

- Areas not suitable for wind development: Wilderness, Recommended Wilderness Study Areas, Eligible Scenic River Corridors, Eligible Recreation River Corridors, Appalachian Trail Corridor, Research Natural Area, Special Geologic Areas, Special Biological Areas, Key Natural Heritage Community Areas, Mount Pleasant National Scenic Area, Shenandoah Mountain Recommended National Scenic Area, Scenic Corridors and Viewsheds, Developed Recreation Areas, Blue Ridge Parkway Scenic Corridor, Shenandoah Mountain Crest-Cow Knob Salamander Area, Indiana Bat Protection Areas, Remote Backcountry Areas.

OIL AND GAS

- The approximately 167,200 acres (or 16% of the GWNF) of mineral rights that are owned by private parties (also called outstanding or reserved mineral rights) are constitutionally protected property rights and would not be affected by implementation of this alternative.

- The approximately 10,200 acres (or 1 percent of the GWNF) of mineral rights that are under current federal oil and gas leases would not be affected by implementation of this alternative.
- The lands currently under lease will be available for leasing after the current leases expire, terminate, or are relinquished.
- The approximately 51,000 acres (or 5% of the GWNF) that are congressionally withdrawn from mineral entry (i.e. Wilderness, and Mount Pleasant Scenic Area) would continue to be legally unavailable for federal oil and gas leasing.
- All other areas would be administratively unavailable for federal oil and gas leasing.

ECONOMICS AND LOCAL COMMUNITY

- Focus is on outputs of ecosystem services, but this results in some increase in timber commodity outputs.

FIRE

- Prescribed fire program between 12,000 and 20,000 acres/year.
- Allow wildfire to attain ecological objectives for biodiversity when appropriate.

CLIMATE CHANGE

- Increase activities to adapt to climate change (improve ecosystem resiliency, restore vegetation composition and structure, aggressive treatment of invasives).
- Source drinking watersheds and impaired waters are a priority for restoration.
- A factor to consider in amount of recommended wilderness areas is the desire for future flexibility.
- Actively restore chestnut, yellow pine, hemlock, spruce, riverfront hardwoods, beaver meadows, fire dependent and adapted communities, open woodlands, TESLR species.
- Timber harvest, fire and grassland/shrubland maintenance are used to manage vegetation structure and composition to improve resiliency of the ecosystems.

NOTE ON ALL ALTERNATIVES: Management activities in Inventoried Roadless Areas (IRAs) are conditional on the 2001 Roadless Area Conservation Rule (RACR). During the development of the issues and alternatives in this EIS, the 2001 RACR was under litigation and subject to changes in policy. Currently the 2001 RACR is in effect and applies to all IRAs. While Forest Plan management direction would allow timber harvest and road construction in some IRAs under Alternatives A, B, D and E, the 2001 RACR would not allow such activities to be implemented. Forest Plan direction under Alternatives C, F, G, H and I would be the same as the 2001 RACR for all of the IRAs.

COMPARISON OF ALTERNATIVES

Table 2-2 displays the allocation of management prescriptions by alternative. It is important to note that the same area of land could be allocated to several Management Prescriptions, such as a Special Biological Area that occurs within a Designated Wilderness or the Appalachian National Scenic Trail Corridor that passes through a Designated Wilderness. The management prescription that has the most stringent management requirements is the one mapped to the area in Table 2-2.

The remainder of this section compares how each alternative addresses the significant issues. This comparison provides a brief summary of Chapter 3 (Environmental Effects of Alternatives) of this Environmental Impact Statement. Alternatives H and I are identical for all issues, with the exception of lands available for oil and gas leasing. For this issue, Alternative I is the same as Alternative C.

Table 2-2. Land Allocation of Management Prescriptions by Alternative, as mapped hierarchically

		ALT A		ALT B		ALT C		ALT D	
RX	RX DESCRIPTION	Acres	%	Acres	%	Acres	%	Acres	%
1A	Designated Wilderness	43,000	4%	43,000	4%	43,000	4%	43,000	4%
1B	Recommended Wilderness Study Areas	1,000	<1%	20,000	2%	387,000	36%	15,000	1%
2C2	Eligible Wild and Scenic River-Scenic	4,000	<1%	3,000	<1%	4,000	<1%	4,000	<1%
2C3	Eligible Wild and Scenic River-Recreation	4,000	<1%	3,000	<1%	4,000	<1%	4,000	<1%
4A	Appalachian Trail Corridor	9,000	1%	9,000	1%	7,000	1%	9,000	1%
4B1	Research Natural Areas	3,000	<1%	2,000	<1%	2,000	<1%	2,000	<1%
4C1	Geologic Areas	0	0%	0	0%	0	0%	0	0%
4D	Special Biological Areas	24,000	2%	51,000	5%	21,000	2%	52,000	5%
4D1	Key Natural Heritage Community Areas								
4E	Cultural Areas		<1%		<1%		<1%		<1%
4F	Mount Pleasant National Scenic Area	8,000	1%	8,000	1%	8,000	1%	8,000	1%
4FA	Recommended National Scenic Areas							8,000	1%
5A	Administrative Sites		<1%		<1%		<1%		<1%
5B	Communication Sites		<1%		<1%		<1%		<1%
5C	Utility Corridors	7,000	1%	7,000	1%	7,000	1%	7,000	1%
7A1	Scenic Byways	5,000	<1%	5,000	<1%	5,000	<1%	5,000	<1%
7B	Scenic Corridors/Viewsheds	44,000	4%	38,000	4%	1,000	<1%	35,000	3%
7C	ATV Use Areas	11,000	1%	10,000	1%	10,000	1%	10,000	1%
7D	Recreation Areas					1,000	<1%	1,000	<1%
7E	Dispersed Recreation Areas								
7E1	Dispersed Recreation Areas-Unsuitable for Timber	39,000	4%	28,000	3%	22,000	2%	21,000	2%
7E2	Dispersed Recreation Areas-Suitable for Timber	5,000	<1%	4,000	<1%			5,000	<1%
7F	Blue Ridge Parkway Corridor			4,000	<1%	4,000	<1%	4,000	<1%
7G	Pastoral Landscapes	6,000	1%	4,000	<1%			4,000	<1%
8A1	Mix of Successional Habitats	258,000	24%					317,000	30%
8A1U	Mix of Successional Habitats-Unsuitable	70,000	7%						
8B	Early Successional Habitats	39,000	4%					34,000	3%
8BU	Early Successional Habitats-Unsuitable	1,000	<1%						
8C	Black Bear/Remote Habitats	74,000	7%					125,000	12%
8CU	Black Bear/Remote Habitats-Unsuitable	61,000	6%						
8E4a	Indiana Bat-Primary Areas	2,000	<1%	2,000	<1%	2,000	<1%	2,000	<1%
8E4b	Indiana Bat-Secondary Area	11,000	1%	14,000	1%	14,000	1%	14,000	1%
8E7	Shen Mtn Crest-Cow Knob Salamander Area	43,000	4%	47,000	4%	20,000	2%	54,000	5%
9A1	Source Water Watershed Protection					143,000	13%		
10B	Timber Production Area	87,000	8%					91,000	9%
10BU	Timber Production-Unsuit	5,000	<1%						
11	Riparian Areas	51,000 acres which are embedded within other prescription areas							
12D	Remote Backcountry	199,000	19%	192,000	18%	114,000	11%	190,000	18%
13	Mosaics of Habitat-Suitable			569,000	53%				
13U	Mosaics of Habitat-Unsuitable					246,000	23%		
Water	Lake Moomaw	2,500	<1%	2,500	<1%	2,500	<1%	2,500	<1%
Total		1,066,000		1,066,000		1,066,000		1,066,000	

Table 2-2. Land Allocation of Management Prescriptions by Alternative (Cont'd)

		ALT E		ALT F		ALT G		ALTS H and I	
RX	RX DESCRIPTION	Acres	%	Acres	%	Acres	%	Acres	%
1A	Designated Wilderness	43,000	4%	43,000	4%	43,000	4%	43,000	4%
1B	Recommended Wilderness Study Areas	24,000	2%	113,000	11%	20,000	2%	27,000	3%
2C2	Eligible Wild and Scenic River-Scenic	4,000	<1%	2,000	<1%	4,000	<1%	2,000	<1%
2C3	Eligible Wild and Scenic River-Recreation	4,000	<1%	4,000	<1%	4,000	<1%	4,000	<1%
4A	Appalachian Trail Corridor	9,000	1%	9,000	1%	9,000	1%	9,000	1%
4B1	Research Natural Areas	2,000	<1%	2,000	<1%	2,000	<1%	2,000	<1%
4C1	Geologic Areas	4,000	<1%	0	<1%	4,000	<1%	3,000	<1%
4D	Special Biological Areas	52,000	5%	30,000	3%	51,000	5%	53,000	5%
4D1	Key Natural Heritage Community Areas					3,000	<1%	3,000	<1%
4E	Cultural Areas		<1%		<1%		<1%		<1%
4F	Mount Pleasant National Scenic Area	8,000	1%	8,000	1%	8,000	1%	8,000	1%
4FA	Recommended National Scenic Areas			128,000	12%			67,000	6%
5A	Administrative Sites		<1%		<1%		<1%		<1%
5B	Communication Sites		<1%		<1%		<1%		<1%
5C	Utility Corridors	7,000	1%	7,000	1%	7,000	1%	7,000	1%
7A1	Scenic Byways	5,000	<1%	5,000	<1%	5,000	<1%	5,000	<1%
7B	Scenic Corridors/Viewsheds	34,000	3%	32,000	3%	35,000	3%	34,000	3%
7C	ATV Use Areas	10,000	1%	10,000	1%	10,000	1%	10,000	1%
7D	Recreation Areas	1,000	<1%	1,000	<1%	1,000	<1%	1,000	<1%
7E	Dispersed Recreation Areas								
7E1	Dispersed Recreation Areas-Unsuitable for Tbr	21,000	2%	15,000	1%	24,000	2%	24,000	2%
7E2	Dispersed Recreation Areas-Suitable for Timber	4,000	<1%	1,000	<1%	4,000	<1%	4,000	<1%
7F	Blue Ridge Parkway Corridor	4,000	<1%	4,000	<1%	4,000	<1%	4,000	<1%
7G	Pastoral Landscapes	4,000	<1%	4,000	<1%	4,000	<1%	4,000	<1%
8A1	Mix of Successional Habitats								
8A1U	Mix of Successional Habitats-Unsuitable								
8B	Early Successional Habitats								
8BU	Early Successional Habitats-Unsuitable								
8C	Black Bear/Remote Habitats								
8CU	Black Bear/Remote Habitats-Unsuitable								
8E4a	Indiana Bat-Primary Areas	2,000	<1%	2,000	<1%	2,000	<1%	2,000	<1%
8E4b	Indiana Bat-Secondary Area	14,000	1%	14,000	1%	14,000	1%	14,000	1%
8E7	Shen Mtn Crest-Cow Knob Salamander Area	50,000	5%	23,000	2%	47,000	4%	24,000	2%
9A1	Source Water Watershed Protection								
10B	Timber Production								
10BU	Timber Production-Unsuit								
11	Riparian Areas	51,000 acres which are embedded within other prescription areas							
12D	Remote Backcountry	264,000	25%	148,000	14%	251,000	24%	201,000	19%
13	Mosaics of Habitat-Suitable	491,000	46%	350,000	33%	508,000	48%	508,000	48%
13U	Mosaics of Habitat-Unsuit	3,000	<1%	109,000	10%				
Water	Lake Moomaw	2,500	<1%	2,500	<1%	2,500	<1%	2,500	<1%
Total		1,066,000		1,066,000		1,066,000		1,066,000	

Access

ISSUE STATEMENT: Forest management strategies may affect the balance between public and management needs for motorized access to Forest lands (for recreation, hunting, management activities, fire suppression) and protection of soil and water resources, wildlife populations and habitat, aesthetics, forest health, and desired vegetation conditions.

Although the road system of the GWNF is largely complete, there are still occasional needs for new roads to access trailheads, manage vegetation, or facilitate mineral development. Table 2-3 displays the estimated road construction miles, road decommissioning miles and the total roads system by the different alternatives, at the end of the first ten years.

Table 2-3. Comparison of the Access Issue by Alternative (miles)

Issue	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Current Roads	1,805	1,805	1,805	1,805	1,805	1,805	1,805	1,805	1,805
Special Use Roads	50	50	50	50	50	50	50	50	50
Potential Forest Highways	129	129	129	129	129	129	129	129	129
Roads to be Decommissioned	N/A	N/A	160	160	80	160	160	160	160
Potential Additional Decommissioning from future wilderness designation	0	0	2	147	6	4	26	2	4
Road Construction	29	18	15	0	41	9	5	15	15
Total Forest Road System at end of 10 years*	1,655	1,644	1,479	1,319	1,581	1,471	1,445	1,479	1,477

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*Special Use Roads and Potential Forest Highways are not included in the Total Forest Road System estimates

Watersheds, Soil and Water Quality, Riparian Resources and Aquatic Diversity

ISSUE STATEMENT: Management activities may affect soil quality, water quality (surface and groundwater) and riparian resources, including drinking water watersheds and those watersheds with streams impaired due to activities off the Forest. Management activities may affect the maintenance and restoration of aquatic biodiversity and may affect species with potential viability concerns.

Table 2-4 highlights several factors associated with this issue. In project implementation, the application of standards for the riparian management prescription and channeled ephemeral stream standards should fully protect drinking water quality. No measureable direct or indirect effects on water quality should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for implementation of standards and for effectiveness of standards. All of the alternatives protect the floodplain/riparian ecological system, but Alternatives B, C, E, F, G, H and I expand the width of the riparian corridor in all watersheds and so increase the area that will receive the riparian management objectives, desired conditions and objectives to protect, restore and maintain riparian resources. Alternative D expands the width of the riparian corridor only within the watersheds containing aquatic threatened and endangered species.

Table 2-4. Comparison of the Watersheds, Soil and Water Quality, Riparian Resources, Aquatic Diversity Issue by Alternative

Issue	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Soil and Water, acres per year									
Areas of ground disturbance	182	72	178-262	66	276-413	175-254	138-200	183-267	183-267
Riparian Areas, feet									
Riparian corridor width-perennial streams	66+	66+	100	100, larger in source watersheds and by impaired streams	100 in aquatic T&E species watersheds, 66'+ in other watersheds	100	100	100	100
Riparian corridor width-intermittent streams	33'+	33+	50	50, larger in source watersheds and by impaired streams	50 in aquatic T&E species watersheds, 33'+ in other watersheds	50	50	50	50
Riparian corridor width-ephemeral streams	N/A	N/A	25	25	N/A	25	25	25	25

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Terrestrial Biological Diversity

ISSUE STATEMENT: Forest Plan management strategies may affect the maintenance and restoration of the diverse mix of terrestrial plant and animal habitat conditions and may affect species with potential viability concerns.

Ecological communities provide the foundation for biological diversity. Ecosystems identified on the Forest include ecological communities that predominate on the landscape (e.g. Central Appalachian Dry Oak-Pine Forest); communities that are declining, rare, or unique (e.g. Caves and Karstlands); and communities that provide habitat for species with potential viability concerns (e.g. Special Biological Areas). By restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems, the GWNF should be able to maintain and improve ecosystem diversity and also provide for the needs of diverse plant and animal species on the forest. Although there are 24 ecological systems on the Forest, for most purposes they can be combined in the following nine ecological system groups: Oak Forests and Woodlands; Pine Forests and Woodlands; Northern Hardwood Forests; Spruce Fir Forests; Cove Forests; Cliff, Talus and Shale Barrens; Mafic Glade and Barrens and Alkaline Glades and Woodlands; Caves and Karstlands; and Floodplains, Wetlands, and Riparian Areas.

Structure and tree age diversity are both characteristics that are important to all forested ecological systems. Table 2-5 compares the structural diversity provided in the alternatives. The early successional forest habitat component includes timber regeneration harvest and natural disturbances, except for Alternative C which has no timber harvest. The active management actions contributing to the changes in habitat components include timber harvest, prescribed fire and wildlife habitat improvements.

Table 2-5. Projected Habitat Components at 10 Years by Alternative

Habitat Component	Current Condition	Alt A	Alt A1	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Early Successional Forest	3%	4%	2%	3-4%	2%	4-6%	3-4%	3%	3-4%	3-4%
Open Woodlands	4%	5%	7%	8-11%	2%	6-8%	11%	8-11%	8-11%	8-11%
Grassland/Shrublands	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mid- to Late Successional Hard Mast Producing Forest	89%	88%	90%	87%	90%	86%	88%	89%	87%	87%
Total Acres Active Management	4%	6%	6%	8-12%	<1%	8-11%	12%	8-11%	8-12%	8-12%

A1 represents the actual implementation level of the 1993 Revised GWNF Plan

Old Growth

ISSUE STATEMENT: Forest management strategies may affect the potential biological and social values associated with the abundance, distribution and management of existing and future old growth.

Old growth provides both biological and social values. Old growth communities provide large den trees for wildlife species such as black bear, large snags for birds and cavity nesters, and large cover logs for other wildlife. Ecologically, old growth provides elements for biologic richness, gene conservation, and riparian area enhancement. Old growth areas provide for certain recreational experiences, research opportunities, and educational study. Other areas have associated historical, cultural, and spiritual values.

There are a variety of viewpoints about old growth forests on public lands. Some viewpoints state the spatial distribution and linkages of patches with varying sizes are important, that old growth communities are underrepresented on private lands, and that the national forests have the best opportunity to provide for these communities. There is also a debate about how old growth should be managed, maintained, or restored. Many people state that old growth areas should be protected or “preserved” and that there should be no harvesting within these areas.

On the other hand, old growth areas are a source of large-diameter, high-value hardwoods, which are limited in supply and in high demand for such products as furniture and finish construction work. Others say that insect and disease risk can be relatively high in old growth stands and could (for some community types) threaten the retention of those stands as old growth. There is concern that fire exclusion could favor a buildup of fire-intolerant, but shade-tolerant, species that could eventually replace the original old growth type.

In Alternatives C, E, and F all stands meeting the definition of existing old growth are unsuitable for timber production. In Alternatives A and B existing old growth in the Dry-Mesic Oak Old Growth Forest Type (OGFT 21) on suitable ground remain suitable for timber production. In Alternatives D, G, H and I old growth in both the Dry-Mesic Oak (OGFT 21) and Dry and Dry-Mesic Oak-Pine (OGFT 25) stands on suitable ground remain suitable for timber production. Since we do not have an inventory of acres that meet the definition of old growth, Table 2-6 displays the estimated level of old growth based solely on stand age. Alternatives C, E and F contain the greatest acreage of estimated old growth ineligible for timber harvest. This is followed by Alternatives A, G, H and I. Alternatives B and D allows for the most potential harvest of old growth.

Table 2-6. Percent of Estimated Old Growth Ineligible for Timber Harvest

OGF Type #	Old Growth Forest Type Name	Estimated Acres of Old Growth	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
1	Northern Hardwood Forest	1,263	100%	100%	100%	100%	100%	100%	100%	100%
2a	Hemlock-Northern Hardwood	2,494	100%	100%	100%	100%	100%	100%	100%	100%
2b	White Pine-Northern Hardwood	688	100%	100%	100%	100%	100%	100%	100%	100%
2c	Red Spruce-Northern Hardwood	118	100%	100%	100%	100%	100%	100%	100%	100%
5	Mixed Mesophytic Forest	5,064	100%	100%	100%	100%	100%	100%	100%	100%
21	Dry- Mesic Oak	151,371	58%	46%	100%	46%	100%	100%	54%	54%
22	Dry and Xeric Oak	331	100%	100%	100%	100%	100%	100%	100%	100%
24	Xeric Pine and Pine Oak	66,468	100%	100%	100%	100%	100%	100%	100%	100%
25	Dry and Dry Mesic Oak-Pine	16,850	100%	100%	100%	48%	100%	100%	55%	56%
28	Eastern Riverfront Forest	6	100%	100%	100%	100%	100%	100%	100%	100%
Total Acreage		244,653								

Forest Health

ISSUE STATEMENT: Forest Plan management strategies may affect the spread and control of non-native invasive species, forest pests, and pathogens, all of which have the potential to affect long-term sustainability, resiliency, and composition of forest ecosystems.

While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpating rare species; impacting recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Even without active management NNIP infestations will occur across the Forest. Insect and disease outbreaks, wildfires, storm events (including wind thrown trees, flooding, landslides, and ice damage) encourage NNIP establishment. Alternative A follows the current Plan which is not as aggressive in controlling NNIP as Alternatives D, E, F, G, H and I. Alternative B only includes integrated pest management and is less aggressive at controlling NNIP than D, E, F, G, H and I. Alternative C would result in the least amount of ground disturbance which could reduce the potential for NNIP infestations; however, the decrease in accessibility in Alternative C could result in less aggressive treatment of NNIP infestations. Alternatives D, E, F, G, H and I all have similar language regarding pre-treatment and post-treatment of areas that will be disturbed. Therefore, the potential for NNIP infestations from ground disturbing activities could be offset by aggressive NNIP treatments.

The GWNF has experienced gypsy moth defoliation since 1987, through 3 to 4 outbreak cycles with a total of about 1.5 million acres defoliated (some acres defoliated in multiple years). Many areas have been defoliated several times, resulting in severe mortality. Although the front of the gypsy moth infestation has passed the forest, the gypsy moth will likely be a part of the Forest’s ecosystem for many years to come. Approximately 867,000 acres of the GWNF is comprised of forest types susceptible to gypsy moth infestation (types where

oak either dominates or is a significant portion of the stand). This represents approximately 81% of the forest in a moderate or severely susceptible host type. While suppression of gypsy moth populations would be permissible under all alternatives, the economic cost and concern for environmental impacts of widespread use of current treatment tactics, primarily the aerial application of insecticides, would result in only a very small amount of the Forest receiving such management actions. Timber harvest and prescribed fire can help reduce gypsy moth risk in upland oak and mixed oak-pine stands. Table 2-7 shows how the alternatives vary in their effect on gypsy moth risk at the end of 50 years of management. Alternative D would have the highest potential to reduce gypsy moth impacts with approximately 45% of the GWNF in a high or extreme gypsy moth risk. Similar conclusions can be made about the effects on oak decline since oak species are the most susceptible to gypsy moth.

Table 2-7. Gypsy Moth Risk at the End of 50 Years of Plan Implementation

Activity in Susceptible Forest Types	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Acres Regenerated (1st decade)	17,000	5,000	11,000	0	23,000	11,000	8,000	11,000	11,000
Acres Thinned (1st decade)	6,000	4,000	4,000	0	8,000	4,000	2,000	4,000	4,000
Total Acres Harvested (1st decade)	23,000	15,000	15,000	0	31,000	15,000	10,000	15,000	15,000
% Acres at High Risk (1st decade)	37%	38%	38%	38%	37%	38%	38%	38%	38%
% Acres at High Risk (5th decade)	34%	39%	37%	39%	32%	36%	38%	36%	36%
% Acres at Extreme Risk (1st decade)	19%	20%	20%	20%	19%	20%	20%	20%	20%
% Acres at Extreme Risk (5th decade)	15%	20%	19%	21%	13%	17%	19%	17%	17%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Unfortunately, most of the hemlocks on the Forest have succumbed to the hemlock woolly adelgid. In some areas, white pine may be able to fill this ecological niche, but it will take time for white pine to fully occupy the sites formerly held by hemlock. Loss of cover is likely to also adversely affect a myriad of bird and wildlife species on the GWNF. Therefore, the difference in the effects on riparian habitat from other management activities between the alternatives is the best way to look at the effects from the hemlock woolly adelgid.

Southern pine beetle (SPB) is a native pest whose infestations have occurred cyclically throughout recorded history in the South. Managers can control both the proportion of susceptible species and the radial growth of trees through vegetation manipulation activities. Thinning and/or regeneration harvests can alter both species composition and radial growth of the trees within a stand. However, thinning in these stands that often occur on relatively poor sites is rarely economically, or even logistically, viable. Many of these stands occur on lands unsuitable for timber production. The use of prescribed fire can reduce stand density, similar to a thinning, and ultimately increase radial growth on the residual stems, thus decreasing susceptibility. Fire can also regenerate some forest types, especially table mountain pine and to a lesser extent pitch pine. Thus, while timber harvest can help to lower SPB risk, the use of prescribed fire can treat the most acres and represents the best tool in lowering SPB risk. Table 2-8 shows how the risk to Southern Pine Beetle varies among the alternatives.

Table 2-8. Acres in Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland Ecological Systems Burned, Regenerated, and Thinned and at Risk from Southern Pine Beetle Effects at the End of the Next Decade by Alternative

Activity in Susceptible Forest Types	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Acres Managed by Fire	3,000	7,400	16,000	10,000	12,000	70,000	16,000	70,000	70,000
Acres Regenerated by Harvest	2,000	300	700	0	3,000	1,500	1,000	1,500	1,500
Acres Thinned by Harvest	0	0	0	0	0	200	0	200	200
Total Acres Vulnerable/High Risk	114,000	111,000	102,000	109,000	104,000	48,000	102,000	48,000	48,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Wind Energy

ISSUE STATEMENT: Responding to opportunities to develop wind energy generation may result in effects on a wide variety of resources (including birds, bats, scenery, trail use, soils on ridgetops, water, noise, remote habitat, local communities/economies, and social values).

Alternative A, the current Forest Plan, does not address this issue. No areas are considered to be unsuitable for wind energy development (except for wilderness and recommended wildereness), though management area guidance would limit road construction and clearing activities in some areas. Alternatives B, F, G, H and I would allow consideration of wind energy development proposals on some areas of the Forest but the following areas are unsuitable for wind energy development: Wilderness, Recommended Wilderness Study Areas, Eligible Scenic River Corridors, Eligible Recreation River Corridors, Appalachian Trail Corridor, Research Natural Areas, Geologic Areas, Special Biological Areas, Key Natural Heritage Community Areas, Mount Pleasant National Scenic Area, Shenandoah Mountain Recommended National Scenic Area (Alternatives H and I), Scenic Corridors and Viewsheds (only in Alternatives H and I), Developed Recreation Areas, Blue Ridge Parkway Scenic Corridor, Shenandoah Mountain Crest–Cow Knob Salamander Area, Indiana Bat Protection Areas, and Remote Backcountry Areas. Alternative D is similar to Alternatives B, F, G, H and I except that wind energy development proposals would be considered in several Remote Backcountry Areas because of the high potential for wind energy development. Alternatives C and E prohibit the development of wind energy across the Forest.

A total of about 117,000 acres of land on the GWNF has been identified as having fair (Class 3) to outstanding (Class 6) wind power potential. Table 2-9 displays the amount of land identified as Class 3 or above that would be unsuitable for wind energy development under each alternative.

Table 2-9. Land in Wind Class 3 or Greater that is Unsuitable for Wind Energy Development (acres)

Issue	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Total Acres with Wind Energy Potential	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000
Total Unsuitable for Wind Energy Development	8,000	70,000	117,000	53,000	117,000	76,000	78,000	82,000

Alternative C and E would have no wind energy development. They would not address the need for alternative energy sources.

Oil and Gas Leasing

ISSUE STATEMENT: Use of National Forest System lands to support energy needs through federal oil and gas leasing may affect forest resources and impact adjacent private lands.

The alternatives respond to the oil and gas issue by varying the amount of acres available for leasing as well as the lease available constraints (Stipulations). Each Management Prescription Area in the Forest Plan identifies if the area is suitable for leasing; and if it is suitable, what surface occupancy stipulation applies. However, in some alternatives (E and H) only portions of the Management Prescription Area are actually made available. In Alternative E, public water supply watersheds are unavailable regardless of which Management Prescription Area they are located. In Alternative H, public water supply watersheds (including the watershed upstream of the Dry River PWS) are unavailable and the area on Shenandoah Mountain south of Highway 250 and above 3,000 feet in elevation is available only with No Surface Occupancy.

In addition, Alternative H makes no decision on the availability of lands on the Lee and Pedlar Ranger Districts, on Walker Mountain on the North River Ranger District, and on Back Creek Mountain and Warm Springs Mountain on the Warm Springs Ranger District. The Reasonably Foreseeable Development Scenario identifies the Marcellus shale as the formation with a high potential for gas and the Marcellus formation is not well represented in these areas. Alternative H emphasizes the development of the Marcellus and withholds a decision on areas with unknown potential.

As a further response to Marcellus Shale concerns, additional stipulations were developed and applied to several of the alternatives. A Horizontal Drilling Moratorium Stipulation and a Horizontal Drilling Operations Control would apply to all Management Prescription Areas where leasing is administratively available in Alternatives B, D, and F. A No Horizontal Drilling Stipulation prohibiting horizontal drilling would apply to: 1) Management Prescription Areas where leasing is administratively available in Alternatives E and G; and 2) public water supply areas in Management Prescription Areas where leasing is administratively available in Alternative F.

The first five rows of Table 2-10 display the number of acres that could be federally leased under four different surface occupancy leasing options (standard terms, controlled, timing, and no surface) for each alternative. The determination of the type of surface occupancy leasing option depends on the management prescription. For example, leasing is allowed in a Scenic Corridor and Viewshed Area but only with a no surface occupancy stipulation. The two rows under the ‘Total Forest Acres’ address horizontal drilling and hydraulic fracturing concerns by applying additional stipulations. Alternatives E and G do not allow any horizontal drilling. Alternative F allows horizontal drilling, but not in public water supply areas. Alternative A allows horizontal drilling with no additional stipulations. Alternatives B and D allow horizontal drilling, with the Moratorium Stipulation and the Operations Control Stipulation. Alternative H allows horizontal drilling but has more restrictive surface occupancy stipulations than the other alternatives; for example, portions of Management Prescription Area 13-Mosaics of Habitat that are in semi-primitive motorized and semi-primitive non-motorized settings have a controlled surface use occupancy stipulation that does not permit road construction. Similar to Alternative C, Alternative I would not make any federal lands available for oil and gas leasing except those currently under lease. Under Alternative I those acres currently under lease would remain available for leasing after the current leases expire, are terminated, or are relinquished.

Table 2-10. Federal Oil and Gas Leasing Availability for Leases by Alternative (thousands of acres)

Issue	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Administratively Available	995	983	0	981	980	763	983	461
Standard Lease Terms	139	615	0	609	535	495	550	236
Controlled Surface Use Stipulation	815	152	0	157	160	105	161	88
Timing Stipulation	0	14	0	14	14	14	14	0
No Surface Occupancy Stipulation	41	202	0	201	271	149	259	137
Administratively Unavailable	10	22	1,005	25	26	242	22	128
Legally Unavailable	51	51	51	51	51	51	51	51
Administratively Available Decision Deferred*	0	0	0	0	0	0	0	416
Available, Under Existing Lease	10	10	10	10	10	10	10	10
Total Forest Acres	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066
Additional Control Measures on Drilling Operations	0	983	0	981	0	731	0	461
Horizontal Drilling Moratorium	0	983	0	981	0	731	0	0
No Horizontal Drilling Stipulation	0	0	0	0	980	32	983	0

*Administratively available decision deferred on Pedlar and Lee Ranger Districts and portions of the Warm Springs and North River Ranger Districts.

To determine the effects of federal oil and gas leasing activity in the future, the Bureau of Land Management (BLM) projected post-leasing activity with a Reasonable Foreseeable Development Scenario (RFD) that estimated that a maximum of 319 natural gas wells, with associated surface disturbance, including well pads, roads, and pipelines, could occur over a 15 year planning horizon on the Forest. This projection of future oil and gas activity was based on the assumption that all the Forest except areas withdrawn from leasing by law would be available for oil and gas leasing under standard lease terms and conditions. Because each alternative will have more restrictive constraints on availability of federal oil and gas leasing by applying different stipulations, each alternative will project less oil and gas activity than the GWNF baseline RFD (as shown in Table 2-11).

Table 2-11. Federal Oil & Gas Lease Activity by Alternative

Altern-ative	Type of Well	Number of wells	Roads (miles)	Pipelines (miles)	Water use for drilling (1,000s of gallons)	Water use for hydraulic fracturing (1,000s of gallons)
Alt A	Vertical wells	39	39	43	787	15,731
	Horizontal wells	198	132	145	19,767	988,350
Alt B	Vertical wells	30	30	33	609	12,177
	Horizontal wells	153	51	56	15,267	763,350
Alts C and I	Vertical wells	0	0	0	0	0
	Horizontal wells	0	0	0	0	0
Alt D	Vertical wells	30	30	33	608	12,158
	Horizontal wells	153	51	56	15,267	763,350
Alt E	Vertical wells	27	13	15	534	10,676
	Horizontal wells	0	0	0	0	0
Alt F	Vertical wells	22	11	12	436	8,722
	Horizontal wells	114	19	21	11,367	568,350
Alt G	Vertical wells	27	14	15	550	10,992
	Horizontal wells	0	0	0	0	0
Alt H	Vertical wells	19	10	10	381	7,611
	Horizontal wells	96	16	18	9,567	478,350

Fire

ISSUE STATEMENT: The management of fire to achieve goals related to protection of property, wildlife habitat, ecosystem diversity and fuels management may affect air quality, non-native invasive species, recreation, water quality, wildlife, and silviculture.

Table 2-12 displays the acres of prescribed fire by alternative in an average year over the next decade.

Table 2-12. Prescribed Burning by Alternative per Year

Acres Prescribed Burned Annually	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
	3,000	7,400	12,000-20,000	Limited	5,000-12,000	20,000	12,000-20,000	12,000-20,000	12,000-20,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Alternative E would be the largest prescribed burn program since it is the restoration alternative and biologically driven. Alternative C would generate the smallest prescribed burn program as prescribed burning would be limited to managing threatened, endangered and sensitive species habitats. Alternative A has the acres estimated to be prescribed burned annually in the current Plan. Alternative D has an emphasis on commodity production and opportunities for prescribed burning would be limited. Alternatives B, F, G, H and I have a program that includes an emphasis on restoration while taking into account fluctuations in weather and funding that may limit the number of acres likely to be burned annually.

Recreation

ISSUE STATEMENT: Forest management strategies should determine an appropriate mix of sustainable recreational opportunities (including trail access) that responds to increasing and changing demands and also provides for public health and safety and ecosystem protection (such as soil and water resources, nesting animals, riparian resources and spread of non-native invasive species).

Local and regional visitors use the forest for a variety of recreational opportunities, from primitive hiking and camping to developed recreation sites and motorized travel. Developed recreation is not a significant issue and it does not vary significantly by alternative. Demand for long-distance trails for special recreation events, such as long-distance mountain bicycling, equestrian endurance rides and runner marathons, has increased in recent years. The demand is greatest among the equestrian and mountain biking communities. There is more demand than supply for motorized trail opportunities. Some comments stated that OHV/ATV use is not appropriate at all on the Forest due to the noise, potential environmental damage, and the need could be met commercially on private lands. Table 2-13 highlights some of the differences between alternatives for dispersed recreation opportunities.

Table 2-13. Comparison of the Recreation Issue by Alternative

Type of Recreation Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Hiking, Pack-and-Saddle, Mountain Bicycling*	Increase 0-3%; <30 miles	No net change	Increase <3%; <30 miles	Increase 5-10%; 50-100 miles	No net change	Increase <3%; <30 miles	Increase <3%; <30 miles	Increase <3%; <30 miles
Effect of Wilderness Designation on Mountain Bicycling**	No change	Loss of 9 miles of trail	Loss of 434 miles of trail	Loss of 1 mile of trail	Loss of 11 miles of trail	Loss of 70 miles of trail	Loss of 9 miles of trail	Loss of 9 miles of trail
All-Terrain Vehicles and Motorcycles	Increase 10-25%; or 6-16 miles	No change	No change	Increase 25-60%; or 16-40 miles	No change	Increase up to 10%; or 6 miles.	Increase 5-10%; or 3-6 miles	Increase 5-10%; or 3-6 miles
Off-Highway Vehicles	Increase 0-25 miles; roads are featured for OHVs.	No featured OHV roads; current level of high clearance roads	No roads managed for OHVs	Increase 20-40 miles; roads are featured for OHVs	No roads managed for OHVs	No featured OHV roads; current level of high clearance roads	No featured OHV roads; current level of high clearance roads	No featured OHV roads; current level of high clearance roads

* Figures used are estimates for analysis and are not intended to place a limit on net miles of new trail added to the system. The actual increase is based on no net increase in trail maintenance. Projects that decommission low use or unsustainable trails and relocate existing trails to more sustainable locations will decrease the maintenance of existing trails. This opens the door for development of new trails.

** The allocation of land to Recommended Wilderness Study will not affect mountain bike use in those areas. However, if Recommended Wilderness Areas are designated as Wilderness by Congress, then all mechanical and motorized transport forms of recreation, such as mountain bicycling, will be prohibited according to the Wilderness Act of 1964.

The alternative with the most emphasis on expanding the existing overall trails program is Alternative D. It provides the greatest increases in the dispersed recreation trail systems, including hiking, mountain biking, horseback riding, ATV, OHV and interpretive trails. Alternative A increases trail construction of both motorized and non-motorized trails and identifies featured OHV roads. Alternatives B and E include no significant increase or decrease in the current motorized or non-motorized miles of trail. Specific OHV roads are not featured in Alternative B, but high clearance roads will continue to be provided for OHV use at the current level. Under Alternative E, no roads are managed for OHVs. Alternative C has the greatest potential for decreased miles of trail available to mountain bicycling users in the future. Mountain bikes will continue to be allowed in Recommended Wilderness Areas, but are prohibited by law when Congress designates an area as Wilderness. Alternative C provides for increased miles of non-motorized trail, as long as there is no increase in trail maintenance costs. Alternative C makes maintenance of the trail system more challenging, as hand tools must be used rather than power tools in areas designated as Wilderness. Alternative F focuses on improving the existing miles of non-motorized trails and improves and expands the existing ATV/OHV trail systems. It promotes a sustainable trails program that allows for expansion only when the resulting level of maintenance will be equivalent to or less than the existing maintenance needs. Alternatives G, H and I provide for increased motorized and non-motorized trail miles when it is beneficial for the resources (such as relocations off of steep slopes and wet areas) and the extra miles result in no net increase in maintenance. Alternatives G, H and I do not identify specific featured OHV routes, but provide for the current level of high clearance roads to be maintained for OHV use.

Wilderness/Roadless

ISSUE STATEMENT: Forest management strategies may affect the balance between the desires for permanent protection of remote areas and the desires for management flexibility and ability to respond to changes in ecological, social and economic conditions when identifying areas to be recommended for Wilderness and determining how potential wilderness areas and other remote areas should be managed.

Wilderness

Table 2-14 lists the Recommended Wilderness Study Areas by alternative. With the exception of Whites Peak, all of the areas are either an Inventoried Roadless Area or Potential Wilderness Area, or both. Whites Peak is a remote area recommended for wilderness study by the local county Board of Supervisors.

Table 2-14. Recommended Wilderness Study Areas by Alternative (acres)

Area Recommended for Wilderness Study (Rx 1B) *	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Adams Peak (PWA, IRA)			8,200					
Archer Knob (PWA)			7,100					
Beards Mountain (PWA, IRA)			10,100					
Beech Lick Knob (PWA)			14,100			11,600		5,700
Big Schloss (PWA, IRA)			28,400			7,200		
Crawford Knob (PWA, IRA)			14,900					
Dolly Ann (PWA, IRA)			9,600					
Duncan Knob (PWA)			6,000					
Elliott Knob (PWA, IRA)			11,100					
Galford Gap (PWA)			6,700					
Gum Run (PWA, IRA)			14,500					
High Knob (PWA, IRA)			5,600					
- Dry Run (IRA)			7,200					
- Skidmore (IRA)			5,600			5,600		

Area Recommended for Wilderness Study (Rx 1B) *	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Jerkemtight (PWA, IRA)			27,300					
Kelley Mountain (PWA, IRA)			12,900					
Laurel Fork (PWA, IRA)			10,200			10,200		
Little Alleghany (PWA, IRA)			15,400			15,400		
Little Mare Mountain (PWA)			11,900					
Little River (PWA, IRA)		9,300	30,200		12,700	12,700	9,300	9,500
Massanutten North (PWA, IRA)			16,600					
Oak Knob-Hone Quarry Ridge (PWA, IRA)			16,300					
Oliver Mountain (PWA, IRA)			13,100			8,700		
Paddy Knob (PWA)			6,000					
Potts Mountain (PWA)			7,000			4,200		
Ramsey's Draft Add. (PWA, IRA)		6,100	19,100		3,100	12,400	6,100	6,100
Rich Hole Addition (PWA, IRA)		4,700	12,100	4,700	4,700	11,100	4,700	4,600
Rich Patch (PWA)			900					
Rough Mountain Add. (PWA, IRA)			2,100		2,100	2,100		1,000
St Mary's North (PWA)			3,000					
St Mary's South (PWA, IRA)	1,500		1,700		1,700	1,700		
St Mary's West (PWA)		300	300	200	200	200	300	300
Shaws Ridge (PWA)			7,300					
Shawvers Run Add (PWA)			100					
Three Ridges Add North (PWA)			100			100		
Three Ridges Add South (PWA)			200			200		
Three Ridges Add SW (PWA)			9			9		
Three Ridges Add West (PWA)			100			100		
Three Sisters (PWA, IRA)			9,900	5,500		5,500		
Southern Massanutten (IRA)			12,100					
The Friars (IRA)			2,000					
Whites Peak				4,200		4,200		
TOTAL ACRES	1,500	20,400	386,800	14,600	24,500	113,300	20,400	27,200

* PWA = Potential Wilderness Area; IRA = 2001 Inventoried Roadless Area

Alternative C recommends all of the Inventoried Roadless Areas and Potential Wilderness Areas for wilderness study. Alternatives B, E, G, H and I focus on stand-alone wilderness areas and wilderness area additions that result in wilderness areas of a size and scale where natural processes can begin to be the dominant influence on the areas. Alternative F was based on recommendations from several wilderness advocacy groups. Many of the Potential Wilderness Area boundaries were adjusted to accommodate important bicycle trails, roads and other uses that would be excluded with wilderness designation. This alternative would result in about 14 percent of the GWNF in Recommended Wilderness Study Areas.

National Scenic Area Recommendations

Since the actual management of any National Scenic Area (NSA) would be determined by the legislation, it is assumed for this analysis that the legislation would be similar to that used to designate other NSAs in Virginia. Designation as a National Scenic Area would prevent the construction of roads, the harvest of timber, the development of minerals, and construction associated with special use permits. Non-motorized recreation would continue, including bicycle use and hunting. The use of prescribed fire would be allowed. In Alternative D the 8,000 acre Adams Peak area is recommended as a National Scenic Area. In Alternative F three National Scenic Area recommendations include: the Virginia portion of Shenandoah Mountain between Highway 33 and Highway 250; Kelley Mountain; and Adams Peak for a total of 130,000 acres. In Alternatives H and I about 67,500 acres (excluding internal areas recommended for wilderness study) are recommended for designation as a National Scenic Area on Shenandoah Mountain.

Potential Wilderness Areas and Inventoried Roadless Areas

The GWNF has 23 Inventoried Roadless Areas (IRAs) with a total of 242,278 acres. As part of the revision process, the Forest identified 37 areas as Potential Wilderness Areas (PWAs) with a total of 372,631 acres. The PWA inventory includes all of the IRAs, with the exception of Southern Massanutten and The Friars. For those remote areas that are not identified for Recommended Wilderness Study or recommended for National Scenic Area designation by Congress, some people would like to see them managed to protect their roadless qualities and others would like to see them actively managed for wildlife habitat and timber production.

Alternative A does not have guidelines that require that all IRAs retain their roadless characteristics, yet the management prescribed for the areas accomplishes nearly the same result. Ninety-five percent of the IRAs are classified as unsuitable for timber production in Alternative A and road construction is prohibited on 88 percent of the areas with some exceptions to provide for site-specific needs. However, this alternative would allow some activities in a few portions of the IRAs that would not be consistent with the 2001 Roadless Area Conservation Rule (RACR). In Alternative C, all of the Inventoried Roadless Areas are recommended as wilderness study areas, thereby protecting their roadless qualities and their management would be consistent with the 2001 RACR. In Alternatives F, G, H and I all of the Inventoried Roadless Areas that are not recommended for wilderness study have direction to maintain their roadless character using a standard prohibiting road construction and timber harvest (with limited exceptions) and their management would be consistent with the 2001 RACR. In Alternatives B, D and E, most of the Inventoried Roadless Areas that are not recommended for wilderness study have the same direction as described for Alternatives F, G, H and I. However, in a few of the areas (nine in Alternative B, six in Alternative D and two in Alternative E) active management (including road construction and timber harvest, which are activities that would not be consistent with the 2001 RACR) would be allowed where active management has occurred along existing roads over the past forty years. These areas are identified in Table 2-15. All other areas of Inventoried Roadless Areas would have management direction to maintain their roadless character. In addition, Alternatives B and D would allow salvage harvest (which would be an activity that would not be consistent with the 2001 RACR) from existing roads with no new road construction in any of the Inventoried Roadless Areas.

Table 2-15. Inventoried Roadless Areas without Plan Direction to Retain Roadless Character (acres)

Inventoried Roadless Area Name	Area	Portions of Area Without Plan Direction to Maintain Roadless Character							
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Crawford Mountain	9,852	N/A	1,200		1,400				
Dolly Ann	7,866	N/A	800		600				
Dry River (WV)	7,254	N/A	500						
Elliott Knob	9,391	N/A	200						
Jerkemtight	16,849	N/A	800		800				
Little Alleghany	10,207	N/A	700		1,000	1,000			
Little River	27,180	N/A	1,000						
Rich Hole Addition	10,919	N/A	1,500		1,500	1,500			
Oak Knob	10,852	N/A	800		1,200				

NOTE: Management activities in Inventoried Roadless Areas are conditional on the 2001 Roadless Area Conservation Rule. During the development of the issues and alternatives in this EIS, the 2001 RACR was under litigation and subject to changes in policy. Currently the 2001 RACR is in effect and applies to all IRAs. While Forest Plan management direction would allow timber harvest and road construction in some IRAs under Alternatives A, B, D and E, the 2001 RACR would not allow such activities to be implemented. Forest Plan direction under Alternatives C, F, G, H and I would be the same as the 2001 RACR for all of the IRAs.

Management of the 144,500 acres in the Potential Wilderness Area (PWA) inventory that are outside of the IRA boundaries varies among the alternatives. Some of the acres are allocated to Recommended Wilderness Study Areas, some are allocated to management prescriptions that emphasis a remote character and some are allocated to management prescriptions that allow active management including road construction and timber production. Table 2-16 below provides a list, by alternative, of the PWAs and their acres that are allocated to areas that allow active management.

Table 2-16. Potential Wilderness Area Acreage (Not in IRAs) Allowing Active Management by Alternative

Potential Wilderness Area Name*	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Adams Peak (PWA, IRA)	900				800		800	800
Archer Knob (PWA)	7,100	7,100		7,100		7,100	2,200	2,000
Beards Mountain (PWA, IRA)	2,600			1,800		1,800	1,800	1,800
Beech Lick Knob (PWA)	14,100	8,500		8,500			5,800	4,900
Big Schloss (PWA, IRA)	7,500	7,500		7,300	7,300		7,300	7,300
Crawford Knob (PWA, IRA)	4,900	4,900		4,900	2,400	2,400	4,900	4,900
Dolly Ann (PWA, IRA)	1,600	1,600		1,600	1,100	1,100	1,100	1,100
Duncan Knob (PWA)	6,000	6,000		5,900	2,300	1,300	2,600	2,600
Elliott Knob (PWA, IRA)	1,700	1,700		1,700	1,700		1,700	1,700
Galford Gap (PWA)	6,700	6,700		6,700	6,700		6,700	6,700
Gum Run (PWA, IRA)	1,900	1,900		1,400				
High Knob (PWA, IRA)	5,600	5,600		5,300			4,100	4,100

Potential Wilderness Area Name*	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Jerkemtight (PWA, IRA)	10,500	10,500		10,400	4,300	4,300	3,700	5,000
Kelley Mountain (PWA, IRA)	5,200	5,200		300	300	300	2,800	2,800
Laurel Fork (PWA, IRA)	200	200						
Little Alleghany (PWA, IRA)	5,200	5,200		5,200	5,200		5,100	5,100
Little Mare Mountain (PWA)	11,900	11,900		11,700		5,400	7,400	7,400
Little River (PWA, IRA)	3,000	3,000		2,400		2,400	1,500	1,500
Massanutten North (PWA, IRA)	7,000	7,000		5,000	5,000	5,000	5,000	5,000
Oak Knob-Hone Quarry Ridge (PWA, IRA)	5,500	5,500		4,400				
Oliver Mountain (PWA, IRA)								
Paddy Knob (PWA)	6,000	6,000		5,100	5,100		5,100	5,100
Potts Mountain (PWA)	7,000	7,000		7,000			7,000	7,000
Ramsey's Draft Add. (PWA, IRA)	6,300	6,300		5,500	4,700		3,400	5,400
Rich Hole Addition (PWA, IRA)	1,300	1,300		1,300	1,300		1,100	1,100
Rich Patch (PWA)	900	900						
Rough Mountain Add. (PWA, IRA)	900	900		800			900	800
St Mary's North (PWA)	3,000	3,000						
St Mary's South (PWA, IRA)	200	200					200	200
St Mary's West (PWA)	300							
Shaws Ridge (PWA)	7,300	7,300		7,200				
Shawvers Run Add (PWA)	100	100						
Three Ridges Add North (PWA)	100	100						
Three Ridges Add South (PWA)	200	200						
Three Ridges Add SW (PWA)	9	9						
Three Ridges Add West (PWA)	100	100						
Three Sisters (PWA, IRA)	1,700	1,700		1,100	1,500		1,500	1,500
TOTAL ACRES	144,500	135,100	0	119,600	49,700	31,100	83,700	85,800

* PWA = Potential Wilderness Area; IRA = 2001 Inventoried Roadless Area

Timber Harvest

ISSUE STATEMENT: Forest Plan management strategies may affect: a) the amount and distribution of land suitable for the sustainable harvest of timber products; b) the amount of timber offered by the Forest; c) the role of timber harvest in benefitting local economies and other multiple use objectives; and d) the methods used to harvest the timber. If the Forest responds to needs for wood biomass energy, unlimited small diameter utilization may affect nutrient cycling, wildlife habitat, and soil productivity and stability. Timber harvest may have effects on other resources.

Table 2-17 compares several indicators for this issue by alternative. The Allowable Sale Quantity is the maximum amount of timber that can be sold on lands suitable for timber production during the first decade of implementing any alternative. The purposes of timber production for Alternative A are to provide early successional habitat for: terrestrial species biodiversity, wood product demand, balanced age class concerns, and increased game populations. Alternatives B, E and F focus the timber program on providing early successional habitat based on terrestrial species biodiversity, ecosystem restoration and other ecological objectives.

Alternative D is the alternative that focuses the most emphasis on providing commodities, jobs and income to the local economies; therefore it has the greatest amount of timber production. Alternative C does not allow for a timber production program.

Table 2-17. Comparison of the Timber Harvest Issue by Alternative

Issue	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Age Class Distribution in 2040 (percent of forested acres)									
0-10 (1% in 2010)	2	0	3	0	4	2	1	3	3
11-40 (9% in 2010)	6	2	7	1	9	5	3	7	7
41-80 (7% in 2010)	10	10	10	10	10	10	10	10	10
81-100 (36% in 2010)	1	1	1	1	1	1	1	1	1
101-130 (33% in 2010)	35	41	36	40	34	38	40	36	36
131-150 (8% in 2010)	26	26	23	28	22	24	25	23	23
150+ (6% in 2010)	20	20	20	20	20	20	20	20	20
Timber Management (thousands of acres)									
Lands Suitable for Timber Production	350	350	499	0	495	367	281	449	452
Acres Regeneration Harvest (Total First Decade)	24	5	30	0	42	18	10	30	30
Million Board Feet (MMBF)									
Allowable Sale Quantity (Total First Decade)	235*	235*	279	0	529	155	96	276	276
Million Cubic Feet (MMCF)									
Allowable Sale Quantity (Total First Decade)	47	47	55.8	0	105.8	31.1	19.1	55.2	55.3
Percent of Current Annual Total Demand for GWNF Timber									
Total Market Demand (255 MMCF/decade)	18	9	22	0	41	12	7	22	22

*In order to compare across the alternatives, the volume shown for Alternative A (current Forest Plan) is shown using the same current Regional conversion factor as the other alternatives, which is different from the conversion factor used in the 1993 Forest Plan.

Alt A[1] represents the effects of the level of activities accomplished during 2009 through 2011.

Economics and Local Community

ISSUE STATEMENT: Management activities may affect the economic role of the Forest, particularly the role it plays in the economy of local communities, including the production of ecosystem services and commodity outputs. Increasing population and development near the Forest may influence access to the National Forest and management activities such as special use requests, fire management, and responses to additional recreation demands.

Table 2-18 highlights the differences between the alternatives' effect to the local communities with respect to economic impacts, such as jobs and income. This table does not include the impacts from Marcellus shale development; however, those impacts are presented in Chapter 3, Section D of this EIS.

Table 2-18. Comparison of the Economics and Local Community Issue by Alternative

Alternative	Average Annual Jobs Contributed by Forest Service Management, Decade 1	Average Annual Labor Income from Forest Service Management (thousands of dollars), Decade 1	Cumulative Decadal Present Net Values of Benefits and Costs (millions of dollars, 4% discount rate cumulative to midpoint of 5th decade)
Alt A	633	$25,021	$1,427
Alt B	623	$21,171	$1,606
Alt C	474	$14,345	$1,339
Alt D	733	$25,743	$1,745
Alt E	565	$19,111	$1,486
Alt F	554	$18,339	$1,676
Alt G	626	$21,308	$1,635
Alts H and I	630	$21,416	$1,641

Climate Change

ISSUE STATEMENT: Changes in climate may require adaptation strategies that facilitate the ability for ecosystems and species to adapt to changes in conditions (such as stream temperature, community vegetation composition, and invasive species). Forest management activities may exacerbate the impacts of climate change or mitigate the impacts through adding to or sequestering carbon or enhancing opportunities for alternative energy sources (wind, biomass, solar).

Based on current projections, the primary regional-level and state-level predicted effects of climate change that would impact the GWNF include: (1) warmer temperatures; (2) extreme weather events; and (3) increased outbreaks of insects, disease, and non-native invasive species. Whether temperatures rise or moisture regimes become drier or wetter, most people support the development of a plan that maintains or restores healthy and resilient ecosystems that can adapt to future changes. Comments suggest that the Plan should address reducing current threats to forest conditions, such as from non-native invasive species, pests and pathogens, acid deposition, or human uses of forest resources. Some comments identify the need to provide migration corridors, which include altitudinal gradients, for plant and animal species, especially those most vulnerable to changing climate conditions. Another adaptation strategy is to reduce other stressors to species that are vulnerable to climate change impacts. Other comments requested that we evaluate how management activities may exacerbate, mitigate or enhance effects of a changing climate. Others identified the importance of the forest's role in carbon sequestration.

The alternatives provide different emphases on both adaptation (ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions) and mitigation (such as carbon sequestration by

natural systems, ways to provide renewable energy to reduce fossil fuel consumption, and ways to reduce environmental footprints). These emphases focus on:

1) Reducing vulnerability by maintaining and restoring resilient native ecosystems;
2) Providing watershed health;
3) Providing carbon sinks for sequestration;
4) Reducing existing stresses;
5) Responding to demands for cleaner energy including renewable or alternative energy; and
6) Providing sustainable operations and partnerships across landscapes and ownerships.

Reduce Vulnerability by Maintaining and Restoring Resilient Native Ecosystems

Alternative C focuses on passive restoration and relies predominantly on natural processes to reduce vulnerability. Alternative C will do some active restoration in reducing roads which may improve the ability for some species to disperse, reduce sedimentation in streams, and reduce the spread of non-native invasive species. The reduction of roads would also reduce access to areas for management activities that could improve diversity and address recreation needs. Alternatives A, B, D, E, F, G, H and I all use a mix of active and passive restoration strategies. Alternative E has the most aggressive approach to active restoration with the largest prescribed fire program and active vegetation management through timber harvest and maintenance of grasslands and shrublands. Alternatives A, B, D, E, G, H and I maintain management options to address changes in the sensitive spruce system in Laurel Fork. Alternatives B, C, D, E, F, G, H and I all utilize the Ecological Sustainability Evaluation tool to develop strategies to maintain and restore the nine ecological systems and the species with special needs. All of these alternatives incorporate the use of wildfire as a tool for achieving resource management desired conditions. All of these alternatives utilize planting of blight-resistant American chestnuts as a restoration tool (Alternatives B, D, E, F, G, H and I allow for more opportunities for planting in open conditions which are likely more conducive to establishment of stands of American chestnut). Alternatives B, D, E, F, G, H and I all maintain or restore ecological conditions that are rare on the GWNF, such as high elevation grasslands and early successional habitat, open woodlands, and old fields. These alternatives all identify the need to address shortleaf pine restoration opportunities.

Watershed Health

Alternative A places a high priority on protecting water quality through the identification of riparian areas and standards that fully protect water quality. This alternative did not address many of the practices and objectives discussed for the other alternatives, but these practices and objectives would be in keeping with the goals of Alternative A.

Alternatives B, C, D, E, F, G, H and I all incorporate the following:

- Beaver meadows, wetlands, and floodplains are protected and restored to improve natural storage, reduce flood hazards, and prolong seasonal flows.
- Riparian forests are protected and restored to moderate changes in stream temperature, maintain stream bank stability, and provide instream habitat.
- Aquatic migration barriers are removed and habitat connectivity re-established so that species can move to more suitable habitat, or move to or from refugia.
- Flood and wildfire risks are reduced in vulnerable watersheds to prevent increased surface erosion and mass wasting leading to aggradation of river channels.
- Roads are improved or decommissioned to reduce adverse impacts during large storms to prevent surface erosion and fill slope failure and landslides. Stream crossings and bridges are constructed to withstand major storm and runoff events.
- Standards are included to assess geologic hazards for management activities, including potential landslide hazards and risks, particularly as the population and infrastructure continue to increase in areas adjacent to the National Forest.
- Bare soil is revegetated as soon as possible and suspend or eliminate recreation uses that are causing elevated sediment levels to streams and large areas of long-term loss of soil productivity outside the designated use area.

- Riparian buffers are increased and standards included for protecting channeled ephemeral streams.
- Soils highly sensitive to acid deposition and nutrient loss are identified. Unlimited small diameter utilization is not allowed in those areas.

Alternative C would have fewer opportunities to restore stream channels, address acidified streams, address geologic hazards and address fire risks than the other alternatives due to the greater acreage in wilderness.

Carbon Sequestration

Alternative C relies on old-aged forests to sequester carbon. The other alternatives use a mix of old-aged forests and harvest to regenerate new forests. The regeneration also has the advantage of creating a diversity of ages and structure in the forest to provide multiple strategies for addressing carbon storage. All of the alternatives are skewed to emphasize a substantial portion of the forest to be in older aged stands.

Forest management in Alternatives A, B, D, E, F G, H and I can increase the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as improved soil and water quality. Planting new trees and improving forest health through thinning and prescribed burning will increase forest carbon in the long run.

Existing Stresses

Aside from the stresses identified in watershed health and restoring resilient native ecosystems, non-native invasive species is a key existing stress on systems. Alternatives B, C, D, E, F, G, H and I all take an aggressive approach to controlling non-native invasive species and preventing their introduction and spread. An early detection and response strategy associated with non-native invasive species will be critical to limit new introductions. Aggressive treatment of established invasive species, along with the control of insects and diseases, are likely to become more critical to maintaining desired conditions for healthy forests under a changing climate. Due to the fragmented land ownership patterns, success in reducing forest pests will sometimes require going beyond national forest boundaries, and continued work with partners will be needed. In addition, management practices (such as thinning and age class diversity) that sustain healthy forests and provide adequate nutrients, soil productivity, and hydrologic function promote resilience and reduce opportunities for disturbance and damage. Alternative C would reduce the spread of many non-native invasive species by restricting management that creates openings in the forest canopy. However, it also restricts the ability to use some control activities in wilderness and to use silvicultural techniques to manage pests like the southern pine beetle.

Alternative Energy Demands

The sources of renewable or alternative energy that can be provided on the GWNF include wind energy, solar energy, and natural gas leasing. Alternative A has the largest area of the GWNF available for gas leasing. Alternatives C and I allow no new federal gas leases. The other alternatives allow for an intermediate level of development. Development of wind energy is allowed in some areas of the GWNF in Alternatives B, D, F G, H and I with the most area available in Alternative D. Alternatives C and E do not allow the development of wind energy on the GWNF.

Sustainable Operations and Partnerships

Under all of the alternatives the GWNF will work with the state of Virginia to incorporate the greenhouse gas emissions from our management activities into a State inventory, just as we have done with the fine particulates inventory. The Forest will continue striving to reduce its environmental footprint and decrease the greenhouse gases emitted through day-to-day operations, including the use of more fuel-efficient vehicles, reducing the number of miles driven and making facilities more energy-efficient. The Forest will also continue working with partners, including other federal agencies, State and local governments, non-governmental organizations and other stakeholders to be more effective in efforts to adapt lands, ecosystems, and species to climate change. Examples are The Nature Conservancy in the Fire Learning Network and the Chesapeake Bay Partnership.

CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

Chapter 3 describes the physical, biological, social, and economic resources of the environment that may be affected by the alternatives presented in Chapter 2, as well as the effects that the alternatives may have on those resources. Affected environment and environmental effects have been combined in this chapter to give a more concise and connected depiction of what the resources are and what may happen to them under the different alternatives. The environmental effects analysis forms the scientific and analytic basis for the comparison of alternatives that appears at the end of Chapter 2.

CHAPTER STRUCTURE

The remainder of this chapter is organized into four sections: A) Physical Environment; B) Biological Environment; C) Social and Economic Environment; and D) Federal Oil and Gas Leasing Availability Decision. Each resource section is organized and presented in the format described below. Since Alternative I is identical to Alternative H with the exception of oil and gas leasing availability, the effects for Alternative I are the same as those for Alternative H in Sections A, B, and C, except where specifically noted. The effects for Alternative I are the same as those for Alternative C in Section D, except where specifically noted.

Affected Environment - Describes the current conditions of the resources. This section may also include history, development, past disturbances, natural events, and interactions that have helped shape the current conditions. It can also describe the geographic area or areas for the analysis of effects. Areas may vary in size depending on the resource, issue, or anticipated activities. This section also describes the time frame over which effects were assessed.

Environmental Consequences
Direct and Indirect Effects – Analyzes the amount and intensity of direct and indirect effects by alternative. Direct effects are caused by an action and occur at the same time and place as that action. Indirect effects are caused by an action but occur later in time or farther removed in distance. Direct and indirect effects are focused on Federal actions. This section also looks at the relationship of temporary (typically 0-3 years), short-term (3-10 years), and long-term (>10 years) effects.

Cumulative Effects – Analyzes the cumulative effects to the resource that may result from the incremental impacts of the alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions.

SECTION A – PHYSICAL ENVIRONMENT

The physical environment is the non-living portion of the environment upon which the living organisms depend—air, soil, water, geology, and climate. This section begins with a description of the ecological classification of the GWNF. The ecological classification is a system that classifies land and water at various scales through integrating information about climate, geology, landform, soils, water, and vegetation. This classification is a tool to provide a more ecological and scientific basis in land and resource management planning.
Ecological classification is useful for:

- Evaluating the inherent capability of land and water resources.
- Predicting changes occurring over time.
- Evaluating effects of management.
- Allocating land to management areas.
- Selecting appropriate management indicators.
- Discussing and analyzing ecosystems and biodiversity at multiple scales.

A1 - DESCRIPTION OF ECOLOGICAL UNITS

The National Hierarchical Framework of Ecological Units is a classification and mapping system for dividing the Earth into progressively smaller areas of increasingly similar ecology. Ecological units are mapped based on patterns of climate, soils, hydrology, geology, landform and topography, potential natural communities, and natural disturbances. These various components take on greater or lesser importance as the mapping scale changes. Conditions dominant at broad scales such as climate and geology are continually related to conditions at finer scales such as biologic communities and soil characteristics.

The GWNF lies within the Central Appalachian Broadleaf Forest - Coniferous Forest - Meadow Province of the Humid Temperate Domain, Hot Continental Division. Most of the James River, Warm Springs, North River and Lee Ranger Districts are located within the Northern Ridge and Valley Section (Ridge and Valley Subsection). Massanutten Mountain lies within the Great Valley Subsection of the Northern Ridge and Valley Section. The western portion of the James River and Warm Springs Districts lie in the Eastern Allegheny Mountain and Valley Subsection, Laurel Fork lies in the Northern High Allegheny subsection of the Allegheny Mountains section. The Blue Ridge Mountain Section contains the Pedlar Ranger District (Northern Blue Ridge Mountains Subsection).

Northern Ridge and Valley Section (M221A)

RIDGE AND VALLEY SUBSECTION (M221AA), GREAT VALLEY SUBSECTION (M221AB)

The Ridge and Valley sections are characterized by long belts of parallel mountains and valleys, the landforms being closely related to the lithology and structure of the bedrock. The ridges consist of sandstone, shales, and siltstone with the occasional bands of limestone on the lower slopes. The valleys are composed of limestone, dolomite and shales. Agriculture and urban areas dominate the valleys, while forestry is the primary use on the oak-hickory covered ridges. These Appalachian oak-hickory and oak-pine forests forming many high gradient, deeply incised streams. Extensive areas of metamorphosed sedimentary rocks occur on the western flank. Deeply weathered bedrock, called saprolite, occurs in some areas of the Blue Ridge. Mesic oak forests predominate, but large pockets of northern hardwoods and spruce-fir can also be found at the highest elevations. Ice, wind and fire are major natural disturbances throughout this section.

Blue Ridge Mountains Section (M221D)

NORTHERN BLUE RIDGE SUBSECTION (M221DA)

The Blue Ridge Mountains Section is the oldest on the Forest. These tectonic uplifted mountain ranges are composed of Proterozoic-Paleozoic igneous and metamorphic rock, forming many high gradient, deeply incised streams. Extensive areas of metamorphosed sedimentary rocks occur on the western flank. Deeply weathered bedrock, called saprolite, occurs in some areas of the Blue Ridge. Mesic oak forests predominate, but large pockets of northern hardwoods and spruce-fir can also be found at the highest elevations. Ice, wind and fire are major natural disturbances throughout this section.

Allegheny Mountains Section (M221B)

NORTHERN HIGH ALLEGHENY MOUNTAINS SUBSECTION (M221BA), EASTERN ALLEGHENY MOUNTAIN AND VALLEY (M221BD)

This Section comprises part of the Appalachian Plateaus geomorphic province. It is a maturely dissected plateau characterized by high, sharp ridges, low mountains, and narrow valleys. It has a prominent structural and topographic grain created by broad, northeast to southwest trending folds in the bedrock. Sandstone and some of the tougher carbonates hold up most of the upland portions; weaker carbonates and shale underlie most valleys. Soils are dominantly Ultisols, Inceptisols, and Alfisols, with mesic temperature regime and udic moisture regime. They are derived from heavily weathered shales, siltstones, sandstone residuum and colluvium, and limestone residuum. Spodosols with frigid temperature regime and aquic moisture regime occur in isolated pockets at the highest elevations. Strongly influenced by elevation and aspect, the vegetation of the Allegheny Mountains can be placed in four broad groups: red spruce, northern hardwoods, mixed mesophytic, and oaks. On average, this Section is notably moister than the Northern Ridge and Valley Section.

A2 – GEOLOGIC RESOURCES

AFFECTED ENVIRONMENT

Geology

Geology is the foundation for a variety of ecosystems. Geologic processes, geologic materials and geologic structures control or influence a host of ecological factors, such as slope aspect, slope steepness, the areal extent of landforms and associated vegetation, the distribution and composition of soil parent material, the structure and composition of vegetation, the physical character of floodplains, wetlands, riparian area, and stream substrates, the quantity and quality of stream water and groundwater, natural disturbance regimes, and the nature and condition of watersheds. Geological diversity is the foundation of ecosystem diversity and biological diversity (Anderson and Ferree 2010).

Surface geologic processes are an important part of the natural disturbance regime in the Forest. These processes include: the erosion, transport and deposition of sediment; mass wasting or landslides; flooding; stream processes; groundwater movement; and the formation of caves, sinkholes and other karst features. These processes are part of the natural disturbance regime in the mountains and affect the Forest in varying degrees every year. Some processes are geologic hazards that create risks to the public.

The interaction of the surface geologic processes with the different geologic formations and geologic structures produced different landforms and different geological settings. The Forest is subdivided into physiographic or geomorphic provinces based on landform, rock types and geologic structure.

VALLEY AND RIDGE PHYSIOGRAPHIC PROVINCE

Most of the Forest is in the Valley and Ridge Physiographic Province, which is a long belt of parallel mountain ridges and valleys trending in a northeast direction. Geologic forces squeezed the originally flat-lying sedimentary layers and folded them into a series of arches (anticlines) and troughs (synclines). Erosion of these folds over geologic time has produced a distinctive repeating landscape of ridges and valleys.

Most of the Forest is located on the strike ridges, which are linear, asymmetric ridges formed by the differential erosion of inclined bedrock layers. One flank of the strike ridge is a steep slope cutting across several bedrock layers (anti-dip or scarp slope). In contrast, the other side of the ridge is a less steep slope conforming to the slope of the underlying bedrock layer (dip slope).

Resistant sandstone or conglomerate forms the top of strike ridges and the mid-to-upper area of the dip slopes. In contrast, the lower flanks of the ridges are underlain by shale, and in some areas, by carbonate bedrock (limestone and dolomite). The valleys are underlain by shale and carbonate bedrock. Some limestone areas contain caves, sinkholes, and other karst features.

Along the western edge of Valley and Ridge Province on the Forest, such as along the Virginia/West Virginia border in Highland County, is a transition zone to the Appalachian Plateau Physiographic Province.

BLUE RIDGE PHYSIOGRAPHIC PROVINCE

The eastern portion of the Forest (Pedlar Ranger District) is located in the Blue Ridge Physiographic Province, in which the northeast-trending Blue Ridge Mountains tower above the eastern border of the Valley and Ridge Province. Granite and other igneous rocks dominate the upper slopes of the Blue Ridge Mountains. Quartzite, sandstone, shale occur on the western slopes of the Blue Ridge as well as large alluvial fans on the lowest slopes.

Geologic Resources

The Forest has a wide range of geologic resources including, but not limited to, groundwater, groundwater-dependent ecosystems, springs, caves, sinkholes, disappearing streams, unusual landforms, waterfalls, fossils (paleontological resources), field records of catastrophic events (floods, landslides, ground collapses, and other geologic hazards), and field records of climatic changes and Quaternary ecosystems. Geologic resources are geologic features, areas, or conditions that are significant to natural resource management or human health and safety or have use or value to society. Geologic resources are identified and managed for scientific, ecological, educational, interpretative, scenic, paleontological, recreational, historic, and other values.

The diversity of geologic processes, structures, and materials are the basis for the diversity of ecosystems. Twenty-four ecological systems, as defined by NatureServe's International Ecological Classification Standards, are identified for the analysis of biological resources. Because many of these ecological systems have similar key attributes, indicators, species associates and resulting forest plan components, the biological analysis combined the 24 ecological systems into 9 major forest communities. As discussed in the biological sections, some of these major forest communities (Alkaline and Mafic Glade and Barrens; Cliff, Talus and Shale Barrens; Floodplains, Wetlands and Riparian; Cave and Karstlands) highlight the geologic foundation of the ecological systems.

KARST AND GROUNDWATER

The Forest's geologic resources include karst terrain underlain by carbonate bedrock (limestone and dolomite). Caves, sinkholes, and sinking streams are characteristic of karst terrain, and provide direct access for surface water to flow directly into the ground water. The geologic resource of groundwater, including groundwater in karst areas, is discussed in the Water section.

Karst terrain is widely distributed across the Forest and occurs on every Ranger District (Figure 3A2-1). These geologic map units containing karst (carbonate bedrock) are estimated to encompass 109,300 acres in Virginia and 9,900 acres in West Virginia. Karst areas may be less than 100% of the geologic map unit because other types of bedrock may be present. These geologic map units indicate 11% of the Forest (about 119,200 acres) with geologic formations containing karst and karst-related groundwater.

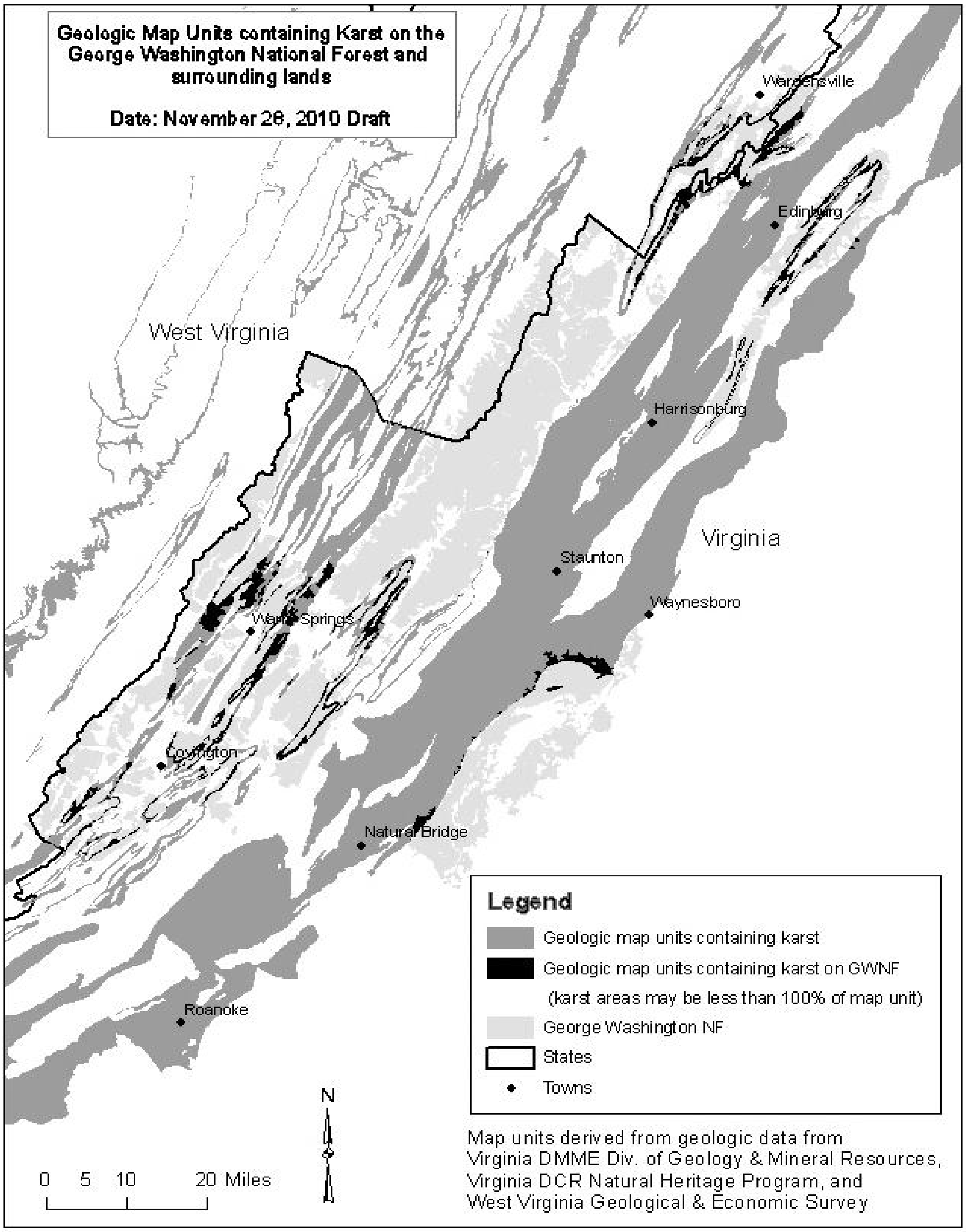


Figure 3A2-1. Geologic Map Units Containing Karst

Trout Pond, a sinkhole pond, may be the only natural lake or pond in West Virginia, and is part of the karst landscape interpreted at the Trout Pond Recreation Area. Maple Flats sinkholes ponds are unusual karst features in an alluvial fan overlying carbonate bedrock. Augusta Springs is a featured nature walk in a karst spring area. Several caves are found on the Forest. The Virginia Department of Conservation and Recreation, Natural Heritage Program, identified 19 cave (and surrounding karst landscape) conservation sites on the Forest. The biological section has more information on cave resources.

Karst groundwater systems are complex, and are even more complex when surficial deposits, such as alluvial fans, mantle the karst bedrock. A notable example is the large alluvial fan along the Coal Road in the Maple Flats area on the north end of the Pedlar District. Thick deposits of sand and gravel overlie Shady dolomite in the Maple Flats sinkhole ponds area and create a complex karst groundwater setting. Another example of a complex karst groundwater setting is the Trout Pond Recreation Area on the Lee District where alluvial deposits overlie karst bedrock.

Geologic Features and Special Interest Areas

Under the current Forest Plan, the Forest has designated two Geologic Special Interest Areas (176 acres total): Devils Garden on the Lee Ranger District (unusual rock pillars, separated by deep fissures); and Rainbow Rocks on the James River Ranger District (huge rainbow of sedimentary strata: anticline).

Some examples of the variety of interesting geologic features on the Forest are:

- Ice Age block fields on Massanutten Mountain are featured in “Glimpses of the Ice Age from I-81” brochure in Geologic Wonders of the Forest series published by U.S. Geological Survey.
- Massanutten Mountain Geologic Story Trail has interpretive displays telling the geologic story of mountain-building, erosion, and geologic history of Massanutten Mountain.
- The Woodstock Observation Tower provides the classic view of the famous Seven Bends of the North Fork Shenandoah River, a geologic text book example of river meanders.
- Jingling Rocks are talus rocks that jingle like wind chimes when wind blows.
- Crabtree Falls, the highest falls in Virginia, has five major cascades and a number of smaller ones that fall a total of distance of 1200 feet.

The Forest has worked in partnership with the U.S. Geological Survey to develop interpretative and education brochures on the Forest’s geologic resources in a Geologic Wonders of the Forest series of brochures.

Paleontological Resources

The Forest contains paleontological resources, primarily Paleozoic invertebrate fossils such as brachiopods, crinoids, coral, gastropods, and scolithus. Recently Congress passed the Paleontological Resources Preservation Act of 2009 which establishes a framework for management and protection of paleontological resources on federal lands. In the Act, the term ‘paleontological resource' means “any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth, except that the term does not include--

> (A) any materials associated with an archaeological resource (as defined in section 3(1) of the Archaeological Resources Protection Act of 1979 (16 U.S.C. 470bb(1)); or
>
> (B) any cultural item (as defined in section 2 of the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001)).”

The Act requires a permit to collect paleontological resources on federal lands except no permit is required for casual collecting where such collection is consistent with the laws governing the management of the federal land and the Act. In the Act, the term ‘casual collecting' means “the collecting of a reasonable amount of common invertebrate and plant paleontological resources for non-commercial personal use, either by surface

collection or the use of non-powered hand tools resulting in only negligible disturbance to the Earth's surface and other resources." The Forest Service is preparing draft regulations for the Act.

Geologic Hazards

Geologic hazards are geologic conditions or phenomena (naturally occurring or altered by humans) that present a risk or are a potential danger to life and property. Forest Service planning regulations require evaluation of existing or potential watershed conditions that will influence hazardous events (36 CFR 219.23(e)). Geologic conditions are part of watershed conditions. Geologic hazards on the National Forests, like fire hazards, affect public safety and property on the Forest and off the Forest in adjacent communities (Collins 2005). The increase in population and infrastructure next to the Forest increases the risks to public safety from geologic hazards associated with the Forest and adjacent private land.

The Forest's main geologic hazards relate to floods, landslides (especially debris flows), landslide dams or woody debris dams, waterfalls, abandoned mines, and karst hazards (sudden ground collapse, sinkhole flooding, and groundwater pollution).

FLOODS

Flooding is a geologic process and natural disturbance that plays a major role in the Forest's watersheds. Flooding also is a key part of geologic processes such as erosion, sediment transport and deposition, and in formation and dynamic changes of floodplains, alluvial fans, and riparian areas. When intense rainfalls occur in the mountains, the steep slopes allow rapid runoff of storm water; the storm waters can overflow creek banks, and then flood across narrow floodplains in narrow valleys. The forests and soils covering the Forest's watershed do moderate runoff and flooding to some extent, but major floods, including flash floods, still occur in the Forest's watersheds. Because the Forest's watersheds are mainly mountainous watersheds with rapid runoff and narrow floodplains, flooding is a geologic hazard on this Forest.

The Water section discusses floods, and mentions notable floods in 1936, 1942, 1949, 1969, 1972, 1985, and 1996. Past floods have damaged Forest roads, trails, developed recreation sites, dams, and other facilities on the Forest. Floods, especially flash floods, create risks to public safety on the Forest, for example, people camping overnight at some developed recreation sites, or people driving roads subject to flash flooding. Preliminary assessments indicate several developed recreation sites are subject to flooding.

Flooding in the mountains of the George Washington Forest is part of a larger geologic process and natural disturbance regime where flooding in mountains contributes to flooding in the valleys and to related geologic processes in the valleys such as erosion, sediment transport and deposition, and changes in floodplains, alluvial fans, and riparian areas. Flooding on the Forest contributes to flooding off the Forest downstream in the watershed. The Forest's watersheds are mainly mountainous watersheds where streams discharge flood waters, bed load, and large woody debris onto private lands in the valleys. As a result, flooding, including flash flooding, on the Forest is a geologic hazard potentially affecting people and infrastructure downstream on private lands.

A debris flood is a flood that incorporates, transports, and deposits so much solid material (such as landslide debris, valley fill, bed load, and/or large woody debris) that the solid material is a major component of the flood, drastically increasing the destructive power of the flood and the resulting flood damage. When infrequent, intense rains fall on the Forest and cause flooding, the mountain watersheds can add into the flood waters both inorganic (rocky debris) and organic (woody debris) materials that can increase the destructiveness of the flood on the Forest and off the Forest.

The role of landslides in creating debris floods was discussed in the Landslide section. The role of woody debris during floods is complex and sometimes contradictory. Large logs and whole trees in flood waters can act as battering rams, eroding the stream banks. This woody debris can form log jams and dams causing severe scour of the channel, mass failure of the stream bank, dam-induced flooding outside of stream channel banks, and debris flood surges due to dam failure. During floods, logs and trees are geologic agents of erosion, just as the flood waters, the suspended load, and the bed load are geologic agents of erosion. However, logs and trees

are also normal components of the stream system. At lower stream flows they can provide stability to the stream channel, reduce the sediment load in streams and improve aquatic habitat. This increase in stability and sediment reduction can also allow the stream system to withstand higher stream flows. Stream channels that are capable of transporting higher flows under stable conditions can reduce the amount of rocky and woody debris that enters the system from eroding stream banks and adjacent landslides.

LANDSLIDES

Because the Forest's watersheds are mainly mountainous watersheds, landslides are an important natural disturbance that plays a major role in flooding, sedimentation, and the functioning of riparian areas. Landslides include a wide range of mass movements such as debris slides, debris flows, slumps, rockslides, rockfall, and stream channel bank failures.

Virginia's deadliest natural disaster occurred on the night of August 19, 1969, when swarms of landslides triggered by the remnants of Hurricane Camille swept down the Blue Ridge and killed 153 people. Hundreds of landslides (debris slides/debris flows) originated on the steep slopes on intermingled private lands and National Forest lands in Nelson, Amherst, and Rockbridge Counties. The landslides scraped the rock, soil and trees off the mountainsides and dumped these deadly landslide masses into storm-swollen streams and valleys. Countless buildings were destroyed and more than a hundred bridges were swept away in parts of Nelson, Amherst, and Rockbridge Counties (Virginia Division of Minerals and Geology 2006).

These Hurricane Camille landslides are a particularly dangerous type of landslide, called a "debris flow". A debris flow typically originates high on a mountainside as a debris slide that gouges down the mountainside (scraping off the soil, weathered bedrock, and trees) and snowballs into a much larger landslide; as this landslide mass sweeps down slope it liquefies into a highly destructive debris flow that can travel hundreds or thousands of feet down slope and downstream from its source area. The Forest typically occupies the steep mountains above populated valleys. As a result, the Forest is a source area for natural debris flows that are a risk to people and infrastructure on and off the Forests.

For example, a June 27, 1995 rainstorm triggered more 40 landslides (debris flows) on the Pedlar Ranger District between Buena Vista and Glasgow on the west side of the Blue Ridge. The debris flows originated on the steep slopes of the National Forest, swept down Belle Cove and other drainages, and discharged destructive masses of rock, earth, and woody debris onto private lands and public roads, including State Highway 501. Sas and Eaton (2008) studied geologic factors affecting these debris flows in Rockbridge County.

The June 27, 1995 rainstorm triggered similar debris flows in the Shenandoah National Park and private lands on the east side of the Blue Ridge in Madison County, Virginia. The U.S. Geologic Survey (USGS) conducted field investigations and produced a series of scientific reports to understand the conditions that cause debris flows and to suggest methods to mitigate future events (Morgan et al. 1997). The USGS also produced a Fact Sheet to help the public and government officials understand and plan for debris flow hazards (U.S. Geological Survey 1996). One purpose for this major scientific effort by the USGS is to help government officials at all levels (federal, state, and local) in Virginia and other parts of the Appalachians understand the important role that land-use planning can have in avoiding or mitigating landslide hazards.

The debris flow hazard also exists on ridges of the Valley and Ridge Province throughout the Forest. For example, June 17-18, 1949 storm triggered more than 100 debris slides/debris flows in the Little River watershed on the North River Ranger District in Augusta and Rockingham Counties, Virginia (Hack and Goodlet 1960)

Debris slide/debris flow landslides originating in the Forest have a potential to cause mass fatalities. These fast-moving landslides start on a steep slope as a failure of colluvium and weathered bedrock (debris slide), and then liquefy and accelerate to speeds as great as 35 miles per hour or more (debris flow), flowing down slope into stream channels, and then downstream. As the debris slide/debris flow moves down slope, it often gouges into the mountainside, scrapping the slopes bare, becoming a much larger landslide, a fast-moving destructive mass that can destroy infrastructure and kill people down slope and in valleys more than two miles

from debris slide source. In the mountainous watersheds typical of the Forest, the destructive power of debris flows is even greater than floods or flash floods. When debris flows occur, they often occur at the time of floods or flash floods; as a result, much of the damage and fatalities due to debris flows sometimes is hidden under the general rubric of "floods", "flood damage", and "flood fatalities". But debris flows are a different type of geologic hazard than water floods or flash floods, and require a more comprehensive geologic assessment. Research in the Appalachian region (Jacobson et al. 1989) indicates that the most catastrophic of geomorphic events will be "those in which conditions simultaneously promote landslides and high flood discharges."

In addition to natural landslides, some landslides may be caused or influenced by human activities. For example, excavation for road construction on a steep slope can undercut and remove some support from the hillside. In some geologic settings (adverse bedrock structures or weak surficial materials), this undercut and removal of support may lead to failure of the road cut-slope. Or, construction of a road fill or log landing fill on a steep slope may lead to a failure of the fill-slope. Slope failures of road cut-slope or fill-slope occur occasionally, generally during intense rainstorms when natural landslides also occur. A geologic hazard related to management activities of special concern are debris flows caused by failure of fill slopes. Destructive debris flows that can sweep hundreds or thousands of feet down slope can be caused not only by failure of natural slopes but also by failure of fill slopes (roads, log landings). On the National Forests of North Carolina in September 2004 Hurricanes Frances and Ivan triggered many road fill failures on Forest Service roads as well as on the Blue Ridge Parkway that resulted in debris gouging destructive paths long distances, endangering people and damaging infrastructure (Collins 2008). Road fills (or log landings fills) on steep slopes may be marginally stable, but vulnerable to failure during intense rainstorms. As demonstrated in September 2004, road fills on a steep slope high on a mountain are a special concern because of the snowball effect as the fill failure transforms to a debris flow and bulldozes the soil, weathered rock, and trees into a larger destructive mass as it gouges down the mountainside. Such debris flows caused by fill failures can travel a mile or two down slope just like debris flows caused by natural slope failures, endangering people and infrastructure down slope and in the valleys.

LANDSLIDE DAMS AND WOODY DEBRIS DAMS

The landslide dams and woody debris dams can occur during intense rainfall, often at times of flooding. In the mountainous terrain with narrow valleys typical of most of the Forest, when a landslide, such as a debris slide, sweeps down slope into a drainage, there is a potential for a landslide dam to form, and soon, to fail as storm water fills upstream of the unstable dam. Woody debris dams also can form and then fail during flooding in forested mountain drainages. The failure of temporary landslide dams or woody debris dams can send a surge of water and debris downstream, and create a different type of "flash flood".

KARST

Karst geology (sinkholes, caves, disappearing streams, etc.) creates multiple geologic hazards:

- Ground collapse at existing sinkholes or new sinkholes can occur at any time, but certain events create elevated threat of catastrophic ground collapse, such as during or shortly after intense rainstorms, or when a new groundwater well or sewage disposal system is placed in operation.
- Sinkholes create unique flood and flash flood hazards. Intense storm waters can suddenly turn dry depressions into ponds or lakes.
- Karst geology creates risk of contamination of ground water and water wells at a developed recreation site as well as down gradient from the site, including private land. Contamination can result from operation and maintenance of the recreation site, such as sewage leakage, or from certain events such as flooding carrying polluted storm water into sinkholes.

For example, sinkhole activity (ground collapse) has occurred in part of these developed recreation sites: Trout Pond Recreation Area on Lee RD; Locher tract on the Glenwood/Pedlar RD; Augusta Springs on the North River RD.

WATERFALLS

Waterfalls are a geologic hazard with a recurring incidence of death or injury to individuals on the Forest. The slick rock, strong current, steep slopes, hidden rocks in the pool beneath the waterfalls, rockfall, ice-covered

rocks, and icicle or ice falls are natural hazards at waterfalls. Visitors who venture too close to the waterfalls have a risk of serious injury or death. Crabtree Falls on the Pedlar RD is a popular recreation site with these natural hazards.

ABANDONED MINES

The Forest has hundreds of abandoned mine workings, primarily from historic mining of iron. Most abandoned mines are in remote locations where Forest visitors generally do not venture. Some abandoned workings, such as shafts or adits, are physical hazards with a risk of falling into a deep shaft or being hit by falling rock in an adit. The Forest has reclaimed hazardous mine workings, and continues this work every year as funding allows. Some reclamation involves bat gates to provide bat habitat.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Geologic Resources

Management activities that involve ground disturbance, such as construction of roads and developed recreation facilities, have the potential to adversely affect geologic resources. All the alternatives have Forest Plan standards to protect the Forest's geologic resources, including groundwater, groundwater-dependent ecosystems, springs, caves, sinkholes, disappearing streams, unusual landforms, waterfalls, and fossils (paleontological resources). The Forest Plan standards to protect geologic resources are in various sections of the Forest Plan, including Geologic Resources, Geologic Hazards, Water, Soil, Caves and Karstlands, and Indiana Bat Management. Standards under all alternatives provide that the location and design of management activities will evaluate measures to avoid, minimize, or mitigate adverse effects on geologic resources with identified values (scientific, scenic, paleontological, ecological, recreation, drinking water, groundwater and groundwater-dependent ecosystems).

Under all alternatives, those management prescriptions that severely restrict or prohibit ground disturbing activity also protect geologic resources located in those management prescription areas, for example, Wilderness, Recommended Wilderness Study Areas, National Scenic Areas, Special Biological Areas, and Remote Backcountry Areas. The measures addressing Terrestrial Viability Evaluation under all alternatives also protect geologic resources because geologic resources are a prominent foundation of several ecosystems such as Alkaline and Mafic Glade and Barrens; Cliff, Talus and Shale Barrens; Floodplains, Wetlands and Riparian; and Cave and Karstlands.

Each Alternative also has a Geologic Area management prescription (4C1) which highlights and provides additional protection for unique geologic resources. Under the current Plan (Alternative A), the Forest has designated two Geologic Special Interest Areas (176 acres total): Devils Garden on the Lee Ranger District and Rainbow Rocks on the James River Ranger District. Alternatives E, G, H and I would add more areas as cave conservation sites to this prescription. The Virginia Department of Conservation and Recreation, Natural Heritage Program, identified 19 cave and surrounding conservation areas on the Forest. Two sites are already within Special Biological Areas (4D), two are within Indiana bat protection areas (8E4), and one is in Wilderness (1A). Alternatives E, G, H and I would add 14 cave and surrounding conservation areas as management prescription 4C1 - Geologic Areas, for a total of about 3,000 acres.

The potential ground-disturbing activities associated with management activities will be used as an indicator of potential impact on geologic resources. Using the acres of Cumulative Long-Term Effects (Table 3A4-3) as an indicator, Alternative C has the lowest potential and Alternative D has the highest potential for impact on geologic resources; Alternatives F, B, E, G, H and I, and A have intermediate levels of potential impact. More analysis on potential effects on groundwater is in Water and Aquatics section.

Geologic Hazards

Geologic hazards are geologic processes or conditions (naturally occurring or altered by humans) that present a risk or potential danger to public safety, infrastructure, and resources. Geologic hazards may affect or be

affected by Forest management activities. Thus, Forest management activities have potential for two types of effects relating to geologic hazards:

Type 1 effect - Forest management activities have the potential to increase risk to public safety, infrastructure, and resources by not considering natural geologic hazards in the location, design, operation, and maintenance of Forest management activities. Different geologic settings on this Forest have different geologic hazards and different potential for hazards. Geologic science can identify high hazard zones; engineering geologic techniques can be used to avoid, reduce or minimize risks to public safety and infrastructure. But if siting, design, operation, and maintenance of Forest management activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk. In the case of facilities, such as campgrounds, the assessment of geologic hazards would apply not only to the facility but also to the access (evacuation route and emergency response route).

Type 2 effect - Forest management activities have the potential to increase risk to public safety, infrastructure, and resources by not considering human-induced geologic hazards in the location, design, operation, and maintenance of Forest management activities. Forest management activities have the potential to 1) trigger or aggravate natural geologic hazards, or 2) create human-induced geologic hazards. In addition to natural landslides, some landslides are caused or influenced by human activities. For example, excavation for road construction on a steep slope can undercut and remove some support from the hillside. In some geologic settings (adverse bedrock structures or weak surficial materials), this undercut and removal of support may lead to failure of the road cut-slope and hillside upslope. Or, construction of a road fill or log landing fill on a steep, geologically unstable slope may lead to a failure of the fill-slope. Such fill failures can transform into a debris flow and travel hundreds or thousands of feet down slope, endangering people and infrastructure on and off the Forest. If siting, design, and maintenance of Forest management activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.

Executive Order 11988 for floodplains is a useful tool that can help mitigate potential effects related to floods, but it does not cover the entire range of geologic hazards and associated risks to public safety and infrastructure. To address the wide range of geologic hazards and to reduce the potential for impacts from management activities, each Alternative has the following forestwide standards:

- When locating, designing, and maintaining trails, roads, other facilities, and management activities, avoid, minimize, or mitigate geologic hazards and potential impact on infrastructure and public safety.
- Site characterization prior to ground disturbance on slope gradients of 40% or greater will: 1) identify existing geologic slope stability conditions; 2) evaluate how construction would alter the existing conditions; and 3) assess potential for slope failures (from cut slopes, fill slopes, disposal sites for excess excavation, and sidecast material).
- For ground-disturbing projects on slope gradients of 40% or greater located upslope and within one-half mile of Forest external boundary, conduct a geologic hazard and risk assessment of off-Forest public safety for landslides, including debris flows.

Each Alternative varies the treatment of developed recreation sites, from no new sites to adding new sites, from expanding sites to closing sites. Using this treatment as an indicator for potential impacts (Type 1) relating to geologic hazards at developed recreation sites, Alternatives E and C have the lowest risk and Alternative A has the highest risk relating to Type 1 geologic hazards effects; Alternatives D, F, B, G, and H and I have intermediate levels of risk to public safety relating to Type 1 geologic hazards effects.

For Type 2 geologic hazards effects, the potential ground-disturbing activities associated with management activities will be used as an indicator of potential to 1) trigger or aggravate natural geologic hazards, or 2) create human-induced geologic hazards that can affect public safety, infrastructure, and resources. Using the acres of Cumulative Long-Term Effects (Table 3A4-3) as an indicator, Alternative C has the lowest potential and

Alternative D has the highest potential for impacts relating to Type 2 geologic hazards; Alternatives A, B, E, F, G, H and I have intermediate levels of potential impact.

Most of the Forest's permanent road system is already constructed. The Forest's road system currently is about 1,800 miles. One indicator of the cumulative effects on geologic resources and geologic hazards is the amount of past, present, and future ground-disturbing management activity on the Forest. The miles of roads are an indicator of the amount of ground-disturbing management activity. Using the miles of road in the minimum road system at end of 10 years (Table 3C8-1) as an indicator, Alternative C has the least cumulative impact and Alternative A has the most cumulative impact; Alternatives B, D, E, F, G, H and I have intermediate levels of cumulative impacts.

About 281 miles of the 1,800 miles of Forest Service System roads are within the 11% of the Forest with geologic formations containing karst. Road construction in Alternatives A, B, D, E, F, G, H and I would add small increments to the 281 miles within the 11% of the Forest with geologic formations containing karst and karst-related groundwater. Alternatives E, F, G, H and I would designate 14 cave and surrounding conservation areas (about 3,700 acres total) as Geologic Special Interest Areas, and thus increase protection of karst groundwater areas.

Over the decades, past Forest management actions included construction and/or expansion of developed recreation facilities, some of which are in areas subject to one or more geologic hazards, such as flooding, landslides and sinkhole ground collapse. Examples of such facilities are Trout Pond Recreation Area, North River Campground, Hone Quarry Campground, Oronoco Campground, and Elizabeth Furnace Campground. Access roads that provide for evacuation or emergency response may also be located in areas subject to geologic hazards. Past management actions include approval of Special Use Permits for organization sites (Camp May Flather and Nature Camp) also subject to one or more geologic hazards. The unintended result or effect of past management has been: 1) recurring damage and costs to repair facilities located in areas of active geologic hazards, such as floodplains, and 2) a legacy of risks to public safety associated with geologic hazards at multiple sites on the Forest. These cumulative effects are part of all of the alternatives, though processes are in place to recognize and reduce potential impacts of geologic hazards.

A3 – CLIMATE

AFFECTED ENVIRONMENT

For the George Washington National Forest and much of the southeastern United States, climate variability and weather events such as strong winds and heavy rains from hurricanes, droughts, heat waves, episodes of warm winters, floods, ice storms, and lightning storms have long been part of the natural environment. From a climate perspective, the southeast has some of the warmest temperatures, generally receives more rainfall than any other region, and experiences many extreme climate events (U.S. Global Change Research Program 2001).

These climate variables and associated disturbances have always influenced the makeup and geographical distribution of many ecological communities and landscapes across the South. However, the increasing changes in climate and disturbances projected for the future are expected to lead to substantial alterations in our forests and the services they provide (U.S. Climate Change Science Program 2008a). The International Panel on Climate Change (IPCC 2007) has identified future impacts of temperature warming, changes in precipitation, extreme weather events, severe droughts, earlier snowfall, rising sea levels and other changes that could significantly affect forest ecosystems.

Forest Service scientists have been studying various aspects of climate change on forests for many years. Yet, our knowledge of how plants and ecosystems respond to the threats of a changing climate and how to react appropriately at local levels where management actions are most effective is still very limited (Solomon 2008). Uncertainties about outcomes will require flexibility, and land management strategies based on current or historical conditions will need to be adjusted or replaced with approaches that support adaptation to changing conditions (USDA Forest Service October 2008).

It has been recognized that forests can play an important role in both mitigating and adapting to climate change. Mitigation measures focus on strategies such as carbon sequestration by natural systems, ways to increase carbon stored in wood products, ways to provide renewable energy from woody biomass to reduce fossil fuel consumption, and ways to reduce environmental footprints. Adaptation measures address ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions. Adaptation and mitigation activities must also complement each other and balance with other ecosystem services (USDA Forest Service October 2008).

At this time, the science of climate change modeling is at the stage of stepping down global models to regional scales (Davis 2007), so a combination of national projections, regional-level climate trends for the southeastern United States, and a recent report prepared for the state of Virginia provides the most reliable context for describing expected climate changes and impacts for the George Washington National Forest. Specifics regarding many mitigation measures, such as the appropriate calculations for carbon offsets and how to consider carbon sequestration rates, are still being developed, so most of our focus at the forest level for now will be on using management options to improve resilience and adaptability of native ecosystems under changing conditions. Then, over the 15-year life of the Plan, as issues are better understood and appropriate measures are identified, climate change strategies can be adjusted through the adaptive management process.

National Climate Change Trends and Expectations

Warming temperatures, altered precipitation patterns, rising sea levels, and increases in the number and intensity of extreme weather events are already causing observed ecological responses across the United States (U.S. Climate Change Science Program 2008a). Although there are variations by region, overall temperatures across the nation warmed during the 20th century, with 11 of the 12 years from 1995-2006 among the warmest since instrumental record keeping was started in 1850 (U.S. Climate Change Science Program 2008b; IPCC 2007). Precipitation patterns and distribution also vary regionally, but the total annual precipitation in the contiguous United States has increased 6.1 percent over the last century, with about half of

the increase attributed to increased storm intensity (U.S. Climate Change Science Program, 2008b; Karl and Knight, 1998). Warming temperatures, along with land subsidence, contribute to sea level rise. Relative sea levels have risen 3-4 mm per year in the Mid-Atlantic States and 5-10 mm per year in the Gulf states (U.S. Climate Change Science Program 2008b; U.S. Environmental Protection Agency 2007).

Anticipated increases in extreme weather events outside the historic range of natural variability may alter the frequency, intensity, duration, and timing of disturbances such as fire, drought, invasive species, and insect and pathogen outbreaks. Changes in forest composition and growth may also have associated impacts on wildlife habitats, the supply of wood products, specialty markets, and recreational opportunities (U.S. Climate Change Science Program 2008b; Marques 2008).

Researchers from The Nature Conservancy examined species diversity in Virginia, West Virginia and other northeastern states and determined that conservation of a full spectrum of geologic classes could offer an approach to conservation that protects diversity under both current and future climates. Anderson and Ferree (2010) found that geological diversity, elevation range, latitude and the amount of calcareous bedrock significantly predicted species diversity. They suggested that protecting geophysical settings would conserve the stage for current and future biodiversity and could be a robust alternative to species-level predictions of effects from climate change.

Forests provide a wealth of services and products including clean water, clean air, biological habitats, recreation opportunities, carbon storage, timber, specialty commodities, fuel, and aesthetic and cultural values. Scientists have indicated that a changing climate can affect the future biodiversity and alter the function of the forest ecosystems that support these services and products (U.S. Climate Change Science Program 2008a). Species distributions may shift, some species are likely to decline while others expand, and whole new communities may form. Forest productivity may be reduced in some instances due to a decline in photosynthesis caused by increased ozone, and productivity may be enhanced in other settings where elevated levels of carbon dioxide (CO_2) have a fertilizing effect on overall tree growth.

The overwhelming majority of studies of regional climate effects on terrestrial species reveal consistent responses to warming trends, including poleward and elevational range shifts of flora and fauna. Responses of terrestrial species to warming across the Northern Hemisphere are already well documented by changes in the timing of growth stages (i.e., phenological changes), especially the earlier onset of spring events, migration, and lengthening of the growing season (IPCC 2007).

Mammalian responses to rising temperatures and other climate changes are diverse. Many small mammals are coming out of hibernation and breeding earlier in the year than they did several decades ago, while others are expanding their ranges to higher altitudes. Some show trends toward larger body sizes, probably due to increasing food availability and higher temperatures. On the other hand, reproductive success in polar bears has declined due to melting Arctic sea ice (IPCC 2007).

Birds are an important part of many functioning ecosystems because of their roles in seed dispersal, pollination, and as both predator and prey. Scientists have observed that birds are breeding and laying their eggs earlier and that migratory species have altered their wintering and/or critical stopover habitats. For example, warmer springs have led to earlier nesting for 28 migrating bird species on the east coast of the U.S. (IPCC 2007).

A range shift toward the poles (northward in the Northern Hemisphere) or to higher elevations has occurred among many invertebrates that are considered pests or disease organisms (IPCC 2007).

Habitat ranges for butterflies in North America have shifted northward and in elevation as temperatures increased. In some cases, such as the Edith's Checkerspot Butterfly, local populations have become extinct in the southern portion of their range (IPCC 2007).

Fishing is highly valued in the U.S. as both a commercial enterprise and as a recreational sport. Fish populations and other aquatic resources are likely to be affected by warmer water temperatures, changes in

seasonal flow regimes, total flows, lake levels, and water quality. These changes will affect the health of aquatic ecosystems, with impacts on productivity, species diversity, and species distribution (IPCC 2007).

Stream habitats are projected to decline across the U.S. by 47 percent for coldwater, 50 percent for coolwater, and 14 percent for warmwater species. In the southern Great Plains, summer water temperatures already approach the limits for survival of many native stream fish (IPCC 2002). An 8°F increase in average annual air temperature is projected to eliminate more than 50 percent of the habitat of brook trout in the southern Appalachian Mountains. The Northern pike, which spawn in flooded meadows in early spring and whose young remain in the meadows for about 20 days after hatching, would be especially affected by low spring water levels. Higher winter temperatures have been observed to decrease the survival rate of the eggs of yellow perch (a coldwater species). On the other hand, one study found that higher winter temperatures (by 2ºC) were beneficial for rainbow trout but the same temperature increase in summer caused negative effects (IPCC 2007).

The ability of reptiles and amphibians to adapt to changes in climate depends in part on their ability to move to more suitable habitat. A European study found that most reptile and amphibian species could expand their ranges in a warmer climate if dispersal were unlimited, but if they were unable to disperse then the ranges of nearly all species (more than 97 percent) would become smaller (IPCC 2007).

Southern Region Climate Change Trends and Expectations

Over the past decade, a number of models have been developed to simulate climatic effects anticipated in the future. These scenarios are based on historical data, trends, and analysis of different plausible assumptions. While climate model simulations are continuing to be developed and refined, climate projections typically do not yet accurately address expected conditions below the regional scale in the United States. In the report by the United States Global Change Research Program on Climate Change Impacts on the United States (2001), the two principal models that were found to best simulate future climate change conditions for the various regions across the country were the Hadley Centre model (developed in the United Kingdom) and the Canadian Climate Centre model. Unless otherwise noted, the following discussions of climate change expectations for the southeastern United States are based on findings from the 2001 U.S. Global Change Research Program report and more recent projections in the U.S. Climate Change Science Program Reports (SAP 4.3 May 2008a; SAP 4.4 June 2008b).

The climate is going to get warmer, especially warmer minimum winter temperatures. Both the Hadley and Canadian models show increased warming in the southeast but at different rates (see inset on Future Climate Scenarios for the southeast). Overall regional temperature changes are projected to be equivalent to shifting the climate of the Southern U.S. to the central U.S. and the central U.S. climate to the northern U.S.

The heat index, which is a measure of comfort based on temperature and humidity, is going to rise. The principal climate model simulations agree that the heat index will increase more in the southeast than in other regions. By 2100, the heat index under the Hadley model is projected to increase by as much as 8-10°F and by over 15ºF in the Canadian model. The Northeast may feel like the southeast does today, the southeast is likely to feel more like today's south Texas coast, and the south Texas coast is likely to feel more like the hottest parts of Central America.

Threats to coastal areas will increase, including rising sea levels, beach erosion, subsidence, salt water intrusion, shoreline loss, and impacts to urban development.

Precipitation is more likely to come in heavy, extreme events.

For other aspects, models tend to differ on expectations. The southeast is the only region where climate models are simulating large and opposite variations in precipitation patterns over the next 100 years. The Canadian model projects more extensive and frequent droughts in the southeast, starting with little change in precipitation until 2030 followed by much drier conditions over the next 70 years. The Hadley model, in contrast, suggests there will be a slight decrease in precipitation over the region during the next 30 years

followed by increased precipitation. There is also uncertainty over the extent of effects of El Nino and La Nina cycles. El Nino events typically result in cooler, wetter winters in the southeast and fewer Atlantic tropical storms, while La Nina events tend to have the opposite effects with warmer, drier winters and more hurricanes.

Unexpected interactions among multiple disturbances happening at the same time add to the level of uncertainty. For example, tree growth is generally projected to be stimulated by increases in CO_2, but limits on availability of water and soil nutrients during droughts often weaken tree health leading to insect infestations or disease, which in turn promotes future fires by increasing fuel loads and further weakening tree health (Marques 2008).

Based on current projections, the following discussion highlights some of the potential impacts of a changing climate on forests in the southeastern United States and on the George Washington National Forest.

Forest productivity. In general, biological productivity of southeastern forests will likely be enhanced by increased levels of CO_2, as long as there is no decline in precipitation and as long as any increases in moisture stress due to higher air temperatures are low enough to be offset by CO_2 benefits. Hardwoods are more likely to benefit from increased CO_2 and modest temperature increases than pines, since pines have greater water demands than hardwoods on a year-round basis. Without management adaptations, simulations using the Hadley model show pine forest productivity will likely increase 11 percent by 2040 and then exhibit a declining trend to an 8 percent increase by 2100 compared to 1990 productivity estimates. Hardwood productivity will likely continue to rise, with projections of a 22 percent increase by 2040 and 25 percent by 2100. This shift in productivity could have significant effects in the South. Forest productivity increases may be offset, however, by escalating damage from forest pests and more extreme weather disturbances.

Forest pests. The potential for a changing climate to increase the distribution of forest insect and disease pests is a concern, particularly for pests that already cause widespread damage such as Southern pine beetles. Higher winter temperatures are expected to increase over-wintering beetle survival rates, and higher annual temperatures will produce more generations each year leading to increased beetle infestations. Other factors, however, complicate projections of future infestation levels. Field research has demonstrated that moderate drought stress increases pine resin production thus reducing colonization success, while severe drought stress reduces resin production and increases pine susceptibility to beetle infestation. Insufficient evidence currently exists to predict which of these factors will control future beetle populations and impacts (McNulty et al. 1998).

Fires. Fire frequency, size, intensity, and seasonality are directly influenced by weather and climate conditions. Nationwide projections show seasonal fire severity is likely to increase by 10 percent over the next century, with possibly larger increases in the southeast. At least two ecosystem models run under the Canadian climate change scenario suggest a 25-50 percent increase in fires, and a shift of some southeastern pine forests to pine savannas and grasslands due to moisture stress. Under a hotter, drier climate, an aggressive fire management strategy could prove critical to maintaining regional vegetation patterns.

Shifts in major vegetation types for the Southeast. The broad variety of ecosystem types found across the southeast ranges from coastal marshes to mountaintop spruce-fir forests. Although the South is one of the fastest growing population regions in the country, forests are still common in many parts of the southeast, and forestland averages approximately 30 percent of each state. Potential changes in vegetation distribution due to climate change vary with different model scenarios. Under the Hadley model, forests remain the dominant natural vegetation in the southeast, but the mix of forest types changes. Under the Canadian model, savannas and grasslands expand and replace parts of the southeastern pine forests along the Coastal Plain due to increased moisture stress. In this scenario, the current southeastern forest moves into the north-central part of the United States. Both drought and increased fire disturbance play an important role in the potential forest breakup.

Weather-related stresses on human populations. Low-lying Gulf and Atlantic coastal areas are particularly vulnerable to flooding. With floods already the leading cause of death from natural disasters in the southeast, increased flooding from more active El Nino/La Nina cycles could have greater adverse impacts. Even if storms

do not increase in frequency or intensity, sea level rise alone will increase storm surge flooding in virtually all southeastern coastal areas. Another concern is the prolonged effect of elevated summertime heat events, which coupled with drought conditions, not only causes elevated heat stress to humans but also increases smog levels.

Increased forest disturbances. Increases in extreme events and changes in disturbance patterns may have more significant impacts, at least in the near future, than long-term changes in temperature or precipitation. Natural disturbances that may be associated with climate change include hurricanes, tornadoes, storms, droughts, floods, fires, insects, diseases, and non-native invasive species. Although disturbances are a natural and vital part of southern ecosystems, it is the change in frequency, intensity, duration, and timing exceeding the natural range of variation that is a concern (Marques 2008). Multiple disturbances interact and further exacerbate damages. Hurricanes can cause severe disturbance that not only results in direct loss of biological communities and habitat, but the widespread damages can also shift successional direction leading to higher rates of species change and faster biomass and nutrient turnover. Invasive species and insect pests often have high reproductive rates, good dispersal abilities, and rapid growth rates enabling them to thrive in disturbed environments.

Water stresses. The difficulty in predicting whether precipitation will increase or decrease in the southeast over the next 30-100 years extends to uncertainties over future water quantity and quality conditions. Current water quality stresses across the southern region of the country are primarily associated with intensive agricultural practices, urban development, and coastal processes such as saltwater intrusion. Although water quality problems are generally not critical under current conditions, stresses are expected to be more frequent under extreme conditions, particularly in low stream flow situations associated with droughts. Under the Hadley model, stream flow in the southeast has been projected to decline as much as 10 percent during the early summer months over the next 30 years. The Chattahoochee and Tombigbee River basins are projected to have decreased water availability over the next 50 years, and as stream flow and soil moisture decrease, agricultural fertilizer applications and irrigation demands tend to increase creating further stress and conflicts over competing uses. Parts of the southeast that depend more on ground water are particularly vulnerable to depletion of aquifers, which can take centuries to recharge after chronic drought conditions (Hoyle 2008).

Outdoor recreation. Outdoor recreation opportunities are likely to be impacted by climate change but would vary by location and activity. Higher summer temperatures could extend summer activities such as swimming and boating but may also reduce other outdoor activities such as hiking and trail use in hot, humid sections of the South. Warmer waters would increase fish production and fishing opportunities for some species but decrease fishing for other cold water species. Summer recreation activities are likely to expand in cooler mountainous areas as temperatures warm along the coastal plain and lowland elevations. Skiing opportunities are likely to be reduced in the South, and some marginal ski areas may close due to fewer cold days and snow events.

Local Level Climate Change Trends and Expectations

The Template for Assessing Climate Change Impacts and Management Option (TACCIMO) was used to estimate the range of changes in precipitation and temperature that can be expected on the GWNF. The template uses models from Canadian Centre for Climate Modeling & Analysis (Canadian-CGCM3), Hadley Centre for Climate Prediction and Research (Hadley-HadCM3), and US Dept. of Commerce/NOAA/Geophysical Fluid Dynamics Laboratory (Commerce-GFDL-CM2.0). The models are run using three scenarios regarding the level of carbon emissions.

Table 3A3-1. Climate Change Model Scenarios

Emissions Path	Description
"Higher" emissions path	Technological change and economic growth more fragmented, slower, higher population growth
"Middle" emissions path	Technological change in the energy system is balanced across all fossil and non-fossil energy sources, where balanced is defined as not relying too heavily on one particular energy source
"Lower" emissions path	Rapid change in economic structures toward service and information, with emphasis on clean, sustainable technology. Reduced material intensity and improved social equity

Based on data from TACCIMO, the predicted changes in precipitation and temperature are shown in the following tables:

Table 3A3-2. Predicted Changes in Precipitation on the GWNF

Precipitation, annual average from 2009-2099 (in)			
Emissions Path	Commerce GFDL-CM2.0 Model	Canadian CGCM3 Model	Hadley HadCM3 Model
Middle Emissions	46.3	43.9	47.7
Higher Emissions	47.0	43.9	44.7
Lower Emissions	44.4	44.8	45.8
Average of all emission options	45.9	44.2	46.1
Historical Average (PRISM 1970-2000)	43.5	43.5	43.5

Table 3A3-3. Predicted Changes in Temperature on the GWNF

Average temperature (ºF, Monthly Average spanning 2009 – 2099)			
Emissions Path	Commerce GFDL-CM2.0 Model	Canadian CGCM3 Model	Hadley HadCM3 Model
Middle Emissions	56.3	56.8	57.7
Higher Emissions	56.8	57.0	57.2
Lower Emissions	55.2	55.2	56.1
Average of all emission options	56.1	56.5	57.0
Historical Average (PRISM 1970-2000)	52.5	52.5	52.5

All of the models predict an increase in precipitation ranging from less than a half inch to more than four inches per year. All of the models also predict an increase in temperature ranging from 2.7° F to 5.2° F.

In December 2008, the Governor's Commission on Climate Change released a "Final Report: A Climate Change Action Plan" for the state of Virginia. The report included expected impacts of climate change on Virginia's natural resources, the health of its citizens, and the economy which included the industries of forestry and tourism. It also identified what Virginians can do to prepare for the likely consequences of climate change as well as an estimation of the amount of, and contributors to, the state's greenhouse gas emissions through 2025. The Governor's Executive Order 59 (2007) set a greenhouse gas emission target of 30% below the business-as-usual projection of emissions by 2025.

The Governor's Commission on Climate Change used the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report as the primary reference point on the science of climate change, and also included testimony of a variety of experts. Estimates provided in the recent Chesapeake Bay Program Scientific and Technical Advisory Committee (STAC) report, "Climate Change and the Chesapeake Bay: State-of-the-Science Review and Recommendations" (Pyke et al. 2008) were also incorporated because of its regionally-specific nature. The findings of the expected impacts of climate change for Virginia from the Commission's report, as they relate to national forest management in Virginia include the following. These impacts could be further compounded by Virginia's growing human population. As of July 2009, the Virginia Employment Commission estimates that, between 2010 and 2030, Virginia's human population will increase by almost 23 percent (http://www.vec.virginia.gov/vecportal/lbrmkt/plugins/lmiapp.cfm/popproj#).

Virginia should prepare for a minimum of a 3.6°F increase in air and water temperatures but these temperatures could increase as high as 10.8°F by 2100. Changes in precipitation and weather patterns are more difficult to estimate, although there has been scientific consensus that most of Virginia will experience a slight (0-10%) increase in precipitation and an increase in coastal storm intensity (IPCC 2008; Pyke et al. 2008).

There will likely be a projected sea level rise for coastal Virginia of 2.3–5.2 feet by 2100. Oxygen levels in the Chesapeake Bay are expected to decrease due to increasing temperatures and increasing storm runoff. Acidification of the Bay and Atlantic Ocean also is a concern as waters absorb more carbon dioxide (CO_2). Though the George Washington National Forest lies along the western mountains of Virginia, all of the forest is in the headwaters of the Chesapeake Bay watershed.

At varying rates, vegetation ranges will move from current locations to higher altitudes and latitudes, such that suitable habitat for some species will decline, other species will become extirpated, and other species will become extinct. Virginia's freshwater streams and high elevation areas currently offer essential habitat to many species that require cooler conditions. As temperatures increase and precipitation patterns change, these habitats will no longer support the same suite of species they do today.

Threats already faced by Virginia's ecosystems, such as invasive species, pathogens and pollution will become exacerbated. Many new exotic or invasive species may move into Virginia and existing pest species may flourish and cause more widespread damage than they are now.

There is a lack of research and specific information on the impacts of climate change on Virginia's forestry industries, and commercial and sport fishing industries.

Virginia's forestlands sequester approximately 23 million metric tons of CO_2 per year but an average of 27,000 acres of forestland is lost annually to development. The George Washington National Forest encompasses about 1 million acres (or seven percent) of the forestlands in the state. The Jefferson encompasses another five percent, making both forests the largest land manager in the state. The GW also includes about 105,000 acres in West Virginia.

Extreme weather events could lead to compromised water and food supplies for people. Unstable weather patterns could also cause periods of drought that threaten municipal water supplies.

Climate change is expected to increase the incidence of human diseases associated with air pollutants and aeroallergens that exacerbate other respiratory and cardiovascular conditions.

The three largest sources of greenhouse gas emissions in Virginia are electricity generation, transportation, and non-utility uses of fuel in industrial, commercial and residential facilities. Demands for electricity, transportation and fuel would likely increase as population increases.

The Virginia Department of Mines, Minerals and Energy (DMME) projects that natural gas consumption will grow 3.6 percent from 2007 through 2016 under a business-as-usual scenario. Natural gas increasingly is being used for electric generation because it is the cleanest of the fossil fuels, which may cause an even greater increase in demand for natural gas supply.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Based on current projections, the primary regional-level and state-level predicted effects of climate change that would impact the Forest include: (1) warmer temperatures; (2) extreme weather events; and (3) increased outbreaks of insects, disease, and non-native invasive species.

Increased variation in temperature and moisture can cause stress and increase the susceptibility of forest ecosystems to invasions by insects, diseases, and non-native species. New environmental conditions can lead to a different mix of species and tend to be favorable to plants and animals that can adapt their biological functions or are aggressive in colonizing new territories (Whitlock 2008). However, changes in adaptability may be too slow given the predicted rate of change. Species that are already broadly adapted may become more prevalent, and species with narrow adaptability may become less prevalent. Disturbance factors that create more vulnerability in native ecosystems or require extensive controls to maintain the status quo are likely to affect desired conditions for healthy and diverse forests.

Desired conditions for healthy forests include resilience to dramatic change caused by abiotic and biotic stressors and mortality agents (particularly the southern pine beetle, gypsy moth, hemlock woolly adelgid and emerald ash borer on the GWNF) and a balanced supply of essential resources (light, moisture, nutrients, growing space). For the GWNF, gypsy moth epidemics have caused the greatest insect damage to date. The hemlock woolly adelgid affects only one species of trees but the loss of hemlocks in the riparian corridors has had widespread impacts, especially when coupled with the continuing effects of acid deposition. The forest has experienced several localized outbreaks of southern pine beetle. Emerald ash borer has been found in the northern parts of Virginia so far.

One of the natural disturbances that are an integral part of the forest is fire. Many of the native ecosystems that make up the George Washington National Forest, such as the pine and pine-oak forests, are adapted to or dependent on some level of periodic fire. Fire frequency, size, intensity, seasonality, and severity are highly dependent on weather and climate. As noted earlier, model results predict that seasonal severity of fire hazard is likely to increase by 10 percent over much of the United States during the 21st century, with possibly larger increases in the southeast (U.S. Global Climate Change Program 2001). The warmer Canadian model scenario which anticipates increased drought stress, projects a 30 percent increase in fire severity for the southeast. If extreme events such as hurricanes further increase forest fuel levels with widespread downed trees, there is a potential for larger, more catastrophic fires that could impact many of the desired conditions for the George Washington National Forest.

Warmer temperatures may lead to increased visitation to the George Washington National Forest for cooler, mountainous temperatures or for water-based recreational opportunities. A longer warm season could lengthen the recreation season on the Forest. Hunting and fishing seasons may be longer. Maintenance needs for roads and infrastructure could be greater. Demand for more highly developed recreation facilities (electricity) may increase. These effects would also be exacerbated by increasing population levels.

Scenery is one of the most valued quality of life benefits for life in the mountains of Virginia and West Virginia. Climatic effects on air quality could alter the visibility of landscapes.

Increases in extreme weather events have the potential for the occurrence of landslides and debris flows. The potential effects may be more important as the population and infrastructure continue to increase in areas adjacent to the National Forest.

The expected effects of climate change to aquatic systems can be described by predicted changes to physical processes and the potential impacts to physical and biological systems (Bakke 2008). For the area covered by the George Washington National Forest, these include:

1) Increased storm intensity, including intensity of precipitation, would increase surface erosion, increase the magnitude and variability of peak flows, and increase sediment load to rivers;

2) Changes to total annual precipitation amount and seasonal distribution, could cause an increase in winter precipitation, a decrease in summer precipitation, an increase in average runoff in winter and spring months, and decreased summer base flows;

3) Increased flood risk and resultant channel instability, would increase channel migration and associated streambank erosion, and shift 100 year floodplain boundaries;

4) Increase in average water temperature would shrink usable habitat for cold water species and shift habitat types. Warmer water temperatures would mean lower dissolved oxygen, and there would be a disproportionate importance of groundwater-fed systems to cold water species. A recent study (Flebbe et al. 2006) projects that rising temperature changes from climate change (and the loss of hemlock along streams) will shrink native trout habitat. Using the Hadley Centre model (2.5^{o}C air temperature increase) and the Canadian Centre model (5.5^{o}C air temperature increase), Flebbe found that between 53 and 97 percent of wild trout habitat could be lost as streams become warmer by the year 2100. However, Trumbo (2010) used a direct measurement approach pairing air and water temperature relationships to classify the sensitivity and exposure (vulnerability) of individual brook trout populations to various climate change scenarios. Trumbo and others (2010) identified potential refugia for brook trout at lower elevations and with higher air temperatures than previous larger scale modeling efforts. Site specific characteristics such as watershed area, percent riparian canopy, solar insolation, percent groundwater, elevation, and percent watershed in forest cover were useful for predicting individual brook trout population persistence.

5) Increased evapotranspiration and loss of soil moisture would reduce baseflow in rivers, reduce groundwater recharge, and result in loss of wetland area, including conversion of perennial to seasonal wetlands;

6) Changes in vegetation cover and species composition could change long-term wood dynamics, alter erosion rates, and change riparian cover and energy inputs (Bakke 2008).

Aquatic systems may not only be affected by changes in the above physical processes in response to climate change, but also by the following changes in human management of land and natural resources:

- Increased demand for structural streambank protection
- Increased groundwater withdrawals in response to declining surface water resources
- Increased demand for irrigation water
- Increased demand for surface water storage and flood control reservoirs
- Increased renewable energy development, impacting new areas on the landscape (Bakke 2008)

Even with more stringent air quality controls, acid deposition is expected to continue to impact the Forest. Research is currently evaluating the link between soil acidification and the nesting success of high elevational birds since female songbirds need large amounts of calcium (from snail shells) to produce eggs (SRS Compass Issue 10). Much of the high elevational habitat for songbirds is found on the GWNF and is one of the more vulnerable habitats to acid deposition on the forest.

In the Aquatic Sustainability Analysis report, watersheds on the Forest were categorized for their sensitivity to acidification. About 67% of the perennial streams on the Forest were found to be within highly sensitive watersheds, based on underlying geology and deposition rates. The smallest streams at the highest elevations, with non-carbonate bedrock were the most susceptible to acidification.

In summary, our more vulnerable ecosystems include:

- Spruce forests (sensitive to acid deposition, occupy higher elevations, habitat for sensitive species)
- Trout streams (sensitive to stream temperatures)
- Pine ecological systems (declining now, susceptible to southern pine beetle, fire-dependent)
- Higher elevation habitats
- Acid sensitive streams
- Acid sensitive soils

We have always experienced droughts, flooding, extreme weather events, catastrophic fire, insects and diseases, and to a more gradual degree, movement in the ranges of flora and fauna species. Many of our current management strategies already strive to maintain or enhance the health and resiliency of various forest resources to better withstand environmental stresses and human-induced pressures. However, the effects of an accelerated rate of change and an increase in the intensity of these impacts on forest resources and ecosystems are still unpredictable. Climate change effects are multiple, varied, and interact with many other stressors/variables. Therefore, an adaptive management approach that monitors forest resource conditions, and monitors the current state of scientific knowledge related to responses to climate change, is needed to allow us to proactively adjust current strategies or adopt new strategies as needed.

The effects of the alternatives focus on both adaptation (ways to maintain forest health, diversity, productivity, and resilience under uncertain future conditions) and mitigation (such as carbon sequestration by natural systems, ways to provide renewable energy to reduce fossil fuel consumption, and ways to reduce environmental footprints). These effects focus on: 1) reducing vulnerability by maintaining and restoring resilient native ecosystems; 2) providing watershed health; 3) providing carbon sinks for sequestration; 4) reducing existing stresses; 5) responding to demands for cleaner energy including renewable or alternative energy; and 6) providing sustainable operations and partnerships across landscapes and ownerships.

Reduce Vulnerability by Maintaining and Restoring Resilient Native Ecosystems

Alternative C focuses on passive restoration and relies predominantly on natural processes to reduce vulnerability. Passive restoration is an important component to any management strategy, but reliance as the main tool is problematic for several reasons. Disturbance regimes do not currently operate at the large scale they did in the past. For example, due to the intermixed ownership, naturally ignited fires do not spread very far on the landscape or remain burning for a very long time period. Without large scale disturbances, large blocks of forest tend towards the same age and condition, making them more susceptible to damage by insects or disease. In addition, the rapid change in climate that is predicted may result in changes in community composition and natural processes may not be able to adapt to these changes due to the rapid pace.

Alternative C will do some active restoration by reducing roads which may improve the ability for some species to disperse, reduce sedimentation in streams, and reduce the spread of non-native invasive species. The reduction of roads would also reduce access to areas for management activities that could improve diversity and address recreation needs.

Alternatives A, B, D, E, F, G, H and I all use a mix of active and passive restoration strategies. Alternative E has the most aggressive approach to active restoration with the largest prescribed fire program and active vegetation management through timber harvest and maintenance of grasslands and shrublands.

Alternatives A, B, D, E, G, H and I maintain management options to address changes in the sensitive spruce system in Laurel Fork. It also allows for opportunities to expand the spruce ecosystem.

Alternatives B, C, D, E, F, G, H and I all utilize the Ecological Sustainability Evaluation tool to develop strategies to maintain and restore the nine ecological systems and the species with special needs. All of these alternatives incorporate the use of unplanned fire ignitions as a tool for achieving resource management desired conditions. All of these alternatives utilize planting of blight-resistant American chestnuts as a restoration tool (Alternatives B, D, E, F, G, H and I allow for more opportunities for planting in open conditions which are likely more conducive to establishment of stands of American chestnut).

Alternatives B, D, E, F, G, H and I all maintain or restore ecological conditions that are rare on the GWNF, such as high elevation grasslands and early successional habitat, open woodlands, and old fields. These alternatives all identify the need to address shortleaf pine restoration opportunities.

Watershed Health

Projected climate changes to the hydrologic cycle through warmer water temperatures, more intense storms, and greater inter-annual variability in precipitation, indicate the importance of maintaining and protecting healthy watersheds. Bakke (2008) describes three key components relating climate change processes to management and conservation of aquatic resources: resilient habitat, refugia, and restoration.

Alternative A places a high priority on protecting water quality through the identification of riparian areas and standards that fully protect water quality. This alternative did not address many of the practices and objectives discussed for the other alternatives, but these practices and objectives would be in keeping with the goals of Alternative A.

In Alternatives B, C, D, E, F, G, H and I:

- Beaver meadows, wetlands, and floodplains are protected and restored to improve natural storage, reduce flood hazards, and prolong seasonal flows. Beaver ponds and wetlands recharge groundwater, raise the water table, retain sediment and organic matter, store water during floods and release it slowly, mitigate low flows and drought, reduce carbon turnover rate, raise pH and ANC, while reducing SO_2, Al, and NO_3 .
- Riparian forests are protected and restored to moderate changes in stream temperature, maintain stream bank stability, and provide instream habitat.
- Aquatic migration barriers are removed and habitat connectivity re-established so that species can move to more suitable habitat, or move to or from refugia.
- Flood and wildfire risks are reduced in vulnerable watersheds to prevent increased surface erosion and mass wasting leading to aggradation of river channels.
- Roads are improved or decommissioned to reduce adverse impacts during large storms to prevent surface erosion and fill slope failure and landslides. Stream crossings and bridges are constructed to withstand major storm and runoff events.
- Standards are included to assess geologic hazards for management activities, including potential landslide hazards and risks, particularly as the population and infrastructure continue to increase in areas adjacent to the National Forest.
- Bare soil is revegetated as soon as possible and suspend or eliminate recreation uses that are causing elevated sediment levels to streams and large areas of long-term loss of soil productivity outside the designated use area.
- Riparian buffers are increased and standards included for protecting channeled ephemeral streams.
- Soils highly sensitive to acid deposition and nutrient loss are identified. Small diameter utilization is limited in those areas.

Alternative C would have fewer opportunities to restore stream channels, address acidified streams, address geologic hazards and address fire risks than the other alternatives due to the greater acreage in wilderness.

Carbon Sequestration

Trees and forests represent major biological "carbon sinks," places where carbon is sequestered. Carbon accrues in trees, soil, and wood products and the use of wood-based substitutes for fossil fuel-based products decreases the amount of greenhouse gas emissions.

The single most important aspect for sequestering carbon is to keep forests as forests. All of the alternatives meet this objective. Older forests sequester large quantities of carbon. Forests (particularly older forests) generally store carbon better than forest products, so harvesting old-growth forests for their forest products is not an effective carbon conservation strategy (Harmon et al. 1990). However, harvest and regeneration of young to middle-aged forests for long-lived forest products can help with carbon storage (Ryan 2008). Alternative C relies on old-aged forests to sequester carbon. The other alternatives use a mix of old-aged forests and harvest to regenerate new forests. The regeneration also has the advantage of creating a diversity of ages and structure in the forest to provide multiple strategies for addressing carbon storage. All of the alternatives are skewed to emphasize a substantial portion of the forest to be in older aged stands.

Forest management in Alternatives A, B, D, E, F G, H and I can increase the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as improved soil and water quality. Planting new trees and improving forest health through thinning and prescribed burning will increase forest carbon in the long run.

The issue of carbon balance in the forest is complicated and affected by many factors. While it is true that forest management activities such as prescribed burning release carbon dioxide into the atmosphere, growing forest vegetation recaptures carbon dioxide. A prescribed burn is, by definition, a low-severity fire that leaves the large trees alive and intact where they continue to store carbon. These fires also tend to stimulate re-growth of grasses and other herbaceous vegetation, which recapture carbon. And low-intensity fires have little effect on the large stores of carbon in the soil. The Environmental Protection Agency (US Environmental Protection Agency 2010) has concluded that when forest management activities (including fire emissions) are considered together with storage/sequestration activities (reforestation, etc.) the cumulative result is a net sequestration of carbon dioxide. This assumes that the proposed activity does not change the land use and the area remains forested, as is the case with prescribed burning on the George Washington National Forest.

Existing Stresses

Aside from the stresses identified in watershed health and restoring resilient native ecosystems, non-native invasive species is a key existing stress on systems. Alternatives B, C, D, E, F, G, H and I, all take an aggressive approach to controlling non-native invasive species and preventing their introduction and spread. An early detection and response strategy associated with non-native invasive species will be critical to limit new introductions. Aggressive treatment of established invasive species, along with the control of insects and diseases, are likely to become more critical to maintaining desired conditions for healthy forests under a changing climate. Due to the fragmented land ownership patterns, success in reducing forest pests will sometimes require going beyond national forest boundaries, and continued work with partners will be needed. In addition, management practices (such as thinning and age class diversity) that sustain healthy forests and provide adequate nutrients, soil productivity, and hydrologic function promote resilience and reduce opportunities for disturbance and damage.

Alternative C would reduce the spread of many non-native invasive species by restricting management that creates openings in the forest canopy. However, it also restricts the ability to use some control activities in wilderness and to use silvicultural techniques to manage pests like the southern pine beetle.

Alternative Energy Demands

Using cleaner energy reduces greenhouse gases. Renewable energy development plays a significant role in the agency's implementation of the Energy Policy Act of 2005, Public Law 109-58 (Testimony by Sally Collins, Associate Chief Forest Service, before the Committee on Energy and Natural Resources, United States Senate,

Renewable Energy on Federal Lands July 11, 2006). The sources of renewable or alternative energy that can be provided on national forest system lands include: wind energy, solar energy, and natural gas leasing.

Alternative A has the largest area of the GWNF available for gas leasing. (See Minerals Section for details) Alternatives C and I allow no gas leasing. The other alternatives allow for an intermediate level of development.

Development of wind energy is allowed in some areas of the GWNF in Alternatives B, D, F G, H and I with the most area available in Alternative D. Alternatives C and E do not allow the development of wind energy on the GWNF.

Sustainable Operations and Partnerships

Under all of the alternatives the GWNF work with States to incorporate the greenhouse gas emissions from our management activities into State inventories, just as we have done with the fine particulates inventory. The Forest will continue striving to reduce its environmental footprint and decrease the greenhouse gases emitted through day-to-day operations, including the use of more fuel-efficient vehicles, reducing the number of miles driven and making facilities more energy-efficient. The Forest will also continue working with partners, including other federal agencies, State and local governments, non-governmental organizations and other stakeholders to be more effective in efforts to adapt lands, ecosystems, and species to climate change. Examples are the Nature Conservancy in the Fire Learning Network and the Chesapeake Bay Partnership.

A4 – SOILS

AFFECTED ENVIRONMENT

The soils are essential to the viability of all organisms occurring on the Forest. Soil develops slowly from various parent materials and is modified by time, climate, macro- and micro-organisms, vegetation and topography. Soils are complex mixtures of minerals, organic compounds, living organisms, air and water. They are a primary component of all ecosystems on the George Washington National Forest.

Past land use has impacted many of the soils on the Forest. Intensive logging, mining, grazing and farming occurred on these lands in the late 1800s and early part of the 1900s. Clearcutting and roading to remove timber for sawmills, iron furnaces and mine props were commonly done over vast acreages. Mining and exploration for iron, manganese, sand, and coal occurred throughout the Forest during the same time period, resulting in many acres being affected by these uses. Some areas were timbered and farmed or grazed prior to Forest Service management, sometimes resulting in soils with gullies and thin topsoil due to erosion.

The distinct surface geology and topography of each Major Land Resource Area (MLRA) occurring on the Forest are described below. These are important factors in the formation of soils on the Forest.

Northern Blue Ridge

The Pedlar Ranger District is located within this area. Roanoke is the southern extent of this MLRA. The rugged mountains of this area have steep slopes, sharp crests and narrow valleys. The soils are mainly derived from metamorphic and igneous rocks. Igneous soil parent material is from granite and gneiss rock types. The metamorphic material is quartzite and shale rocks.

The soils of the ridgetops and upper one-third of the slopes generally have less depth and are less productive than soils forming on the lower slopes. Rock outcrops are common. Aspect plays a key role in site productivity and available moisture, as northerly aspects tend to be moister and more productive. This is because there is less evapotranspiration and lower soil temperatures on these slopes. Ridgetops and slopes of the higher elevations have soils with a thick, dark organic surface layer. The growing season is shortened at these higher elevations, in part because of lower mean annual soil temperatures.

Some soils derived from granite on upper slopes on the Pedlar Ranger District are underlain by highly weathered granite rock (saprolite). This material has no structure and is unstable on steep slopes when exposed. Soils forming in areas underlain by quartzite have lower productivity on most upper slopes because of low fertility associated with this rock type. Upper slopes on the western front of this area have rock outcroppings and soils are shallow and very droughty. Lightning strike fires are common due to dry conditions.

Many of the lower and gentler slopes have deeper soils and higher productivity than the soils on the upper slopes. Clay content tends to be higher, as is moisture holding capacity in soils on lower landscapes. Some of these soils have a high rock content, both in surface and subsurface layers. Hardened layers (fragipans) have formed in some colluvial (gravity deposited) soils that produce seasonal high (perched) water tables.

Alluvial (water deposited) soils, associated with larger streams, have some floodplain areas where soil drainage is slow. Watertables may be seasonally high, or have small wetlands occurring. Larger floodplains have a variety of drainage conditions. The smaller drainages have alluvial soils that have very narrow floodplains and better drainage. Rock content in soils of the smaller drainages can be high. Productivity of the alluvial soils in this section is usually high. Plant species are influenced by fluctuating soil watertables and varying soil drainage conditions.

Northern Appalachian Ridges and Valleys

The remainder of the Forest is located within this MLRA. It is a folded and faulted area of parallel ridges and valleys. Sandstone and shale ridges are separated by narrow to moderately broad limestone and shale valleys.

The topographic orientation of these valleys and ridges is dominantly northeast to southwest. Soils have developed from sedimentary rocks, such as shales, sandstones and limestones. Residual soils of the ridgetops and upper slopes are predominantly derived from sandstone. Soil depths are generally 10-to-40 inches to hard bedrock. Productivity is low, water holding capacity is low and soils are very porous. Rock outcrops and high rock content within the soil are common. Upper slopes, dominated by shale rocks, have very shallow soil depths. This causes rapid water runoff during storm events. Most of the shale bedrock is rippable (easily broken when excavated) and not hard.

Midslopes are mixed shales and sandstones, relating to extensive folding and faulting of the bedrock layers. The Forest has very little area with soils derived from limestone. Where they occur, these soils have more clay, are variable in depth and very productive. Other midslope soils are generally 20-to-60 inches deep to sandstone and less deep when underlain by shale. Soils derived from the shale have low pH and a high runoff potential due to shallow depths and steep slopes. Productivity varies as deeper shale-derived soils and soils on northerly aspects have moderate-to-high productivity, and sandstone derived soils and southerly aspects have moderate-to-low productivity.

Lower slopes have deeper soils and more clay in the subsoil. Water-holding capacity is better and productivity is generally higher. Some colluvial soils on gentle slopes have formed cemented layers (fragipans), which cause perched watertables during the winter and early spring months. Many of the colluvial soils on toeslopes and along drainages have very high rock content throughout the soil profile. Surface stones and boulders are common.

Alluvial soils are commonly well drained along most streams. Larger streams have broader areas of floodplain soils with various drainage conditions. Small areas of organic soils are associated with upland bogs and slackwater areas, which generally form at the edges of floodplains and nearly level headwater areas of some watersheds. Wetlands are usually small in areal extent, and some have been formed behind old beaver dams.

Riparian and Wetland Soils

In the lowest parts of the landscape are the soils associated with riparian areas and wetlands. These soils are of limited extent on the Forest, but important for biodiversity and water quality. Riparian-wetland soils constitute one of the largest freshwater reservoirs on Earth. They are an important component of both standing water (lentic) systems, such as swamps, marshes, bogs, and running water (lotic) systems such as rivers, streams, and springs. Riparian-wetland areas are the “green zones” or links, between aquatic environments and upland, terrestrial ecosystems. Healthy riparian-wetland areas provide several important ecological functions. These functions include water storage and aquifer recharge, filtering of chemical and organic wastes, sediment trapping, streambank building and maintenance, flow energy dissipation, and primary biotic (vegetation and animal) production.

Riparian-wetland areas are intimately related to their adjacent waterways since the presence of water for all or part of the growing season is their distinguishing characteristic. In fact, the nature and condition of a riparian-wetland area fundamentally affects the aquatic ecosystem. In addition to water, there are three other essential components of the riparian-wetland areas: soil, vegetation, and landform. In a healthy riparian-wetland ecosystem, the four are in balance and mutually supporting one another.

Because of the presence of water, riparian-wetlands have soil properties that differ from upland areas. For example, most upland areas are derived from in-place weathering processes and relatively little soil material is derived from offsite sources. In contrast, riparian–wetland soils are constantly changing because of the influx of new material being deposited by different storm events and by overland flow. As a result, great variability in soil types can occur in short distances.

This great variation in soils has an effect on hydrology, vegetation, as well as on erosion and deposition. The soil in streambanks and floodplains and the substrate under the channel act as a sponge to retain water. This stored water is released as subsurface water or ground water over time, extending the availability of water in the watershed for a longer period during the summer or recharging the underground aquifer. Water flow restricting soil features such as clay or hardpans often have layers that support perched water tables of

standing water in riparian-ecosystems. Water movement over, into, and through the soil is what drives surface hydrology in our streams and filters our ground water.

Vegetative composition of riparian-wetland areas is also strongly influenced by the amount of moisture and oxygen levels in the soil. For example, the type of riparian-wetland soil, the amount of soil organic matter, the depth to which the water table will rise, the climate, and the season and duration of high water all determine the kinds of plants that will grow in riparian-wetland areas.

Erosion, though natural in some amounts, must be in balance with the amount of water and vegetation to prevent excessive erosion and sediment. Soils, interacting with geology, water, and vegetation, play a critical role in determining watershed health and, thus, the rate of erosion on uplands and deposition in riparian and wetland areas.

Soil Resource Issues

Research indicates that soil productivity is sustained through nitrogen and carbon fixation, mineral release from weathering parent material, decaying organic matter, and translocation of nutrients. Soil displacement, erosion and compaction can affect long-term and short-term productivity. The Forest has a completed detailed soil survey. Soil productivity improvement opportunities exist in watersheds with deteriorating soil conditions associated with human causes. Many of these conditions are caused by eroding abandoned roads, eroding trails, abandoned minespoils, illegal vehicle use, trash dumps, and dispersed camping.

The soils on the Forest are important to local and regional communities in several ways:

- Soils support vegetation, which supports wildlife, timber, and varied vegetative ecosystems.
- Soils in good condition produce little sediment to streams and reservoirs.
- Suitable soils are essential to any recreation use and development.
- Suitable soils are essential to a successful road and trail system.
- Watershed improvement project work can help local economies through purchases of supplies, equipment and labor.
- Soils on the Forest are an essential ecosystem component to consider in all the multiple uses the Forest provides to communities in our region.

Specific issues regarding impacts to soils were identified during public scoping for this Forest Plan. They are summarized here.

- Effects to soil productivity from motorized access use, soil movement (erosion), changes in dedicated use of the land, road decommissioning, illegal vehicle use, ATV and OHV use areas, dispersed recreation use.
- Management activities on the Forest may affect soil productivity. Soils could be impacted by acid deposition, road construction and decommissioning, trails and dispersed recreation use, watershed improvements, soils low in natural fertility, steep slopes and conservation of soil organic matter.
- Wind energy development. Construction and operation of wind farms on ridgetops and steep slopes.
- Prescribed fire management and containment with dozers.
- Recreation impacts from trail use, construction and closure, illegal motorized use and dispersed use in riparian corridors.
- Timber management impacts from small diameter utilization harvest, nutrient cycling and wood product transport from stump to roads.
- Climate change and impacts from using carbon sequestration within wetlands (beaver and restoration of artificially drained land), woody biomass harvest and biomass harvests for energy production.

The most important soil resource issue/concern regarding the effects from the management activities proposed in the various alternatives of the Forest Plan Revision is soil productivity. Ensuring that the quality of the soil resources across the George Washington National Forest is maintained or improved is what will be

discussed and displayed in this EIS. We will describe impacts to soil productivity with estimates of areal extent (acres). Some of the impacts will be short-term (<100 years) and some will be longer-term.

We will show how each alternative will impact the long-term productivity of the soil and to what extent. A significant impact to soil productivity will be an estimated fifteen percent reduction in productivity for areas that we actively manage. The threshold for allowable impacts to soil productivity has been identified by most regions of the Forest Service as 15 percent of an activity area. Long-term soil productivity must be maintained on at least 85 percent of an activity area. The activity area for this EIS varies by alternative since each one proposes different levels of management on different areas of the Forest. When long-term soil productivity is reduced on fifteen percent or more of an area, then this would not be in compliance with the laws and policy guiding FS protection of soil productivity and ecosystem sustainability.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

By determining the acres of long-term effects to soil productivity for each alternative, we can compare the alternatives and show how extensive the effects are. Each alternative affects long-term soil productivity to some degree. Key indicators used for determining effects to the soil resource are:

- Acres of timber harvest
- Miles of road construction
- Acres of prescribed burning
- Miles of trail construction
- Acres of soil improvement
- Acres of mineral lease development (used in Section D, Soils Resource)
- Acres of dispersed recreation
- Miles of road decommissioning

The scope for the soil resource effects analysis for the proposed actions and the alternatives is calculated using potential areas of disturbance (activity areas) below. These vary by alternative and will be used as a basis to display the percent of the activity area that is estimated to have long-term impacts to soil productivity. Activity Areas will be used to describe the scope of this analysis.

Table 3A4-1. Activity Area Acres Considered for Potential Soil Disturbance on GWNF

	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
GW Acres included in Activity Area*	1,021,551	1,002,447	636,140	1,008,299	998,601	910,782	1,002,612	995,202

* Activity Area calculated by subtracting acres in: Prescription Areas: 1A Designated Wilderness and 1B, Recommended Wilderness Areas, from the total Forest acres (1,065,918). The prescription areas vary by alternative. Other land allocations of prescriptions with low levels of potential disturbance, such as 2C2, 4B1, 4C1, 4F, 4FA, 8E4a, 8E7 and 12D, could be impacted by fire line construction associated with prescribed fire management, so these areas were not subtracted.

The Forest Service is directed by a number of laws, executive orders and policies to protect or enhance long-term soil productivity, while providing for the various uses of the National Forests. The Forest and Rangeland Renewable Resources Planning Act (RPA 1974) requires an assessment of the present and potential productivity of the land. Regulations are to specify guidelines for land management plans developed to achieve the goals of the program that "...insure that timber will be harvested from National Forest System lands only where ...soil, slope or other watershed conditions will not be irreversibly damaged." The National Forest Management Act (1976) amended RPA by adding sections that stressed the maintenance of productivity, the protection and improvement of soil and water resources and avoidance of permanent impairment of the productive capability of the land.

Soil productivity is the inherent capacity of the soil to support the growth of plants and can be measured in terms of biomass produced. We will not measure impacts to soil productivity with biomass, since it is difficult to

quantify. We will describe impacts to soil productivity with estimates of areal extent (acres). Some of the impacts will be short-term (<100 years) and some will be long-term. We want to show how each alternative will impact long-term soil productivity and if these cumulative impacts will be extensive. A significant impact to soil productivity will be a fifteen percent reduction in productivity in areas where we do management. When long-term soil productivity is reduced on fifteen percent or more of the GWNF activity area by any alternative, then this would be a significant impact to the soil resource and would not be in compliance with the laws guiding FS policy on protecting soil productivity. By identifying impacts to soil productivity and minimizing the extent of the impacted area, we can protect the soil's ability to function as an important part of the Forest's ecosystems.

The threshold for significant impacts to soil quality/productivity has been identified in Forest Service Handbook 2509.18 Sec.2.05 as 15 percent of an activity area. Long-term soil productivity must be maintained on at least 85 percent of an activity area. Activity areas are where potential soil disturbances are most likely to occur and they are also expected to produce biomass in the future. By determining the extent (acres) of long-term effects to soil productivity for each alternative, we can compare the alternatives and show how extensive the effects are. Each alternative affects long-term soil productivity to some degree. Soil productivity can be affected by various factors and conditions resulting from management activities on the Forest. Compaction, erosion, topsoil removal (displacement), land use changes (i.e. forestland to trailhead parking) and soil improvement (fertilization/liming) can result from actions we take and all of these impacts the local productivity of the soil. Natural geologic weathering processes (rock to soil), organic decomposition (breakdown of dead biomass), fire, nutrient cycling and atmospheric (precipitation) additions are also influencing soil productivity across the Forest. All effects to soils from proposed actions will also be analyzed at the project level.

Table 3A4-2. Types of Effects to Soil Productivity

Direct Effects	Indirect Effects
Compaction	Erosion/soil movement
Land use change	Nutrient cycling
Displacement (Topsoil removal)	Prescribed fire use
Soil improvement	

Compaction. Soil compaction is dependent upon soil texture, soil structure, soil moisture, ground cover, rock content and the type of activity. Soils are most susceptible to compaction when moisture content is high. Fine textured soils without rock fragments are more at risk. Research has shown that biomass production (a measure of soil productivity) is reduced on compacted soils in the early stages of site recovery. Rutting, increased runoff, erosion and reduced root/plant growth can occur on severely compacted soils. Large areas of the Forest have surface soil characteristics that reduce their susceptibility to compaction. Low clay content and high rock content of the surface soil layers help reduce impacts to soil productivity from compaction. If topsoil removal occurs, generally compaction is more likely, since the subsoil layers of many soils on the Forest have higher clay content and have less rockiness. However, if topsoil removal has occurred, then soil productivity has already been reduced on the area. Compaction is considered a short-term (less than 100 years) effect on soil productivity, since research has shown even severely compacted soils can recover in ten to sixty years where mitigation measures of tilling and reestablishing vegetation have been used. Depth of compaction does not commonly exceed six inches with the kinds of equipment being used on the Forest. Actions that can produce soil compaction associated with Forest Plan Alternatives are skid trail (unbladed access routes) use, timber harvesting, grazing and trail use.

Land Use Change. If a soil on the Forest has the ability to produce biomass, it then has soil productivity. If this same soil, for example, is converted to a parking lot, building site, road or into some other use that prevents it from producing biomass, then it has lost some or all of its productivity for a long time. Land use change will be considered a long-term impact to soil productivity at this planning level.

Displacement (Topsoil Removal). Topsoil removal is considered a long-term effect to soil productivity because it involves the loss of the most fertile part of the soil. The organic layer and the mineral A-horizon beneath it are where most of the feeder roots are located for plants and where most of the nutrients needed for soil productivity are found. Many of the Forest's soils are formed in sandstones and shales that are naturally low in nutrients used by plants. Many are also acidic (low in soil pH). This means the upper layers of soil, where most of the organic material and microorganisms are found, are very important in maintaining the soil's productivity. Many years are needed for the soil to recover its original productivity when the upper layers are removed. Soil formation typically occurs at a rate of one inch per 200-1000 years and depends on many local environmental factors.

However, areas where topsoil is disposed will be enriched with this added soil material and organic matter. Productivity on these topsoil disposal areas will be improved by increasing soil depth, rooting depth, moisture holding capacity and organic matter. This is not to say that where topsoil is removed (long-term reduced soil productivity), soil productivity will be offset by areas where topsoil is deposited (long-term improved soil productivity). It is mentioned here as an indirect effect of excavation activities and to document that not all effects from excavation are negative. Topsoil disposal areas will not be used to show any positive effects of excavation, since the extent of these areas is not easily estimated or displayed. Actions which can produce topsoil removal associated with Forest Plan Alternatives are temporary road and skid road construction, log landing construction, developed recreation construction and use, new trail construction and relocation, and fireline construction using bulldozers.

Soil Improvement. The Forest works to improve soil conditions and reduce soil movement on about 40 acres per year. The Forest also decommissions roads annually. Special emphasis is given to riparian areas to help reduce sediment delivery to stream channels, floodplains and wetlands. Some watersheds may be targeted for this work to tie in with priority watersheds, watershed partnerships, species habitats and public water sources. The effects of soil improvement will be considered a long-term positive effect on soil productivity and an improvement of existing soil conditions. Soil improvement work will help these treated soils toward recovery of their inherent soil productivity. Actions which would be considered soil improvement associated with Forest Plan Alternatives include, road decommissioning, slope stabilization, erosion control structures and vegetation, road and trail decommissioning, illegal traffic use areas treated for compaction and erosion, abandoned mined land reclamation and trash dumpsite cleanups.

Prescribed Fire Use. Prescribed burning impacts soils in two ways. One way the fire itself burns up portions of the soil's organic layer, an important part of soil productivity. Hotter fires with large fuel loads will burn up more of the organic matter than cooler fires. A few soils on the Forest, with thin organic layers, can lose their entire organic layer when a fire burns hot. Typically, these would be shallow, rocky soils at or near ridge tops on steep slopes. In most cases, on this Forest, the effects of fire on the soil are a short-term effect. Organic layers are replenished by leaf fall and native vegetation takes advantage of a temporary increase in available soil nutrients from the fire, and an existing root system to recover. Also associated with prescribed burning is the construction of bladed firelines to control the burned area boundary. This is considered topsoil removal and is a long-term impact to soil productivity. Not all firelines are bladed with dozers.

Erosion/Soil Movement. An indirect effect of removing a soil's vegetative cover and its organic layer is erosion, meaning soil movement. An undisturbed soil with soil layers intact and covered with growing biomass is not very susceptible to erosion. When soils are disturbed in some way to expose bare mineral soil (A-horizon and lower), then soils on slopes become susceptible to raindrop impact, soil displacement and downslope flow of soil with water. These forces can cause soil to move, sometimes into stream channels, where it then becomes sediment and is incorporated into the bed load of the stream channel. Exposed slopes with low clay soils and soils without many rock fragments are most susceptible to soil movement.

Erosion is considered here as soil movement and not soil loss. Soil material may or may not move from a site or to a stream channel. Many factors influence soil movement and when soil moves, it is deposited somewhere. Depositional areas may benefit from the addition of this eroded soil. Gully erosion is the extreme case of soil movement and would be considered a long-term effect to soil productivity. Gully erosion is evidence that large amounts of soil have moved away and will not be replaced in the short-term (<100 years). Other forms of erosion are not as impactive and would only last until a vegetative cover is established. Gully

erosion is difficult to predict and depends on several factors. Erosion will be considered a short-term effect and will be estimated mainly to consider sediment delivery to stream channels.

Nutrient Cycling. When vegetation is removed from a site, a portion of the potential organic matter and its available nutrients to the soil is removed with it and the resulting condition of a reduced canopy (shade) can have an effect on soil temperature, soil moisture and nutrient cycling. This situation will normally occur with a timber harvest. The bole of the tree is removed from the site and the forest canopy opens up to allow more sunlight and moisture to reach the soil surface. Other parts of the tree will remain onsite to recycle into the soil nutrient system over time. Loss of trees will reduce canopy cover and evapotranspiration and increase soil moisture. Loss of canopy will increase soil temperature in the topsoil. These conditions will increase soil organic matter decomposition and increase available nutrients on the treated area. Much of this increase in plant available nutrients will be taken up by the stump sprouting of hardwood trees and by the root systems of the remaining vegetation on the treated area. Some nutrients may be leached from the site and reach local streams in ground water. This leaching effect is short-term and research has shown that removal of the tree main stem alone will not reduce long-term soil productivity. Most tree nutrients are in smaller branches and leaves, which normally remain on site after a timber harvest. Short-term losses are made up by leaf fall, atmospheric additions and weathering of parent material. Any increased leaching of nutrients from the soil would be very short-term (<5 years).

Long-term productivity can be reduced with unlimited small diameter utilization with short rotations on soils with poor natural fertility so small diameter utilization is limited on these soils.

The cumulative effects to soil productivity from the actions taken during the first decade of a new Forest Plan by each alternative are displayed in Table 3A4-3 below. Table 3A4-3 is based on the levels of timber harvest and prescribed fire displayed in Table 3B2-10. As shown, the alternatives vary in their impact to long-term soil productivity on the Forest. It shows that soil productivity is being maintained on more than 99% of the Forest area. Cumulative effects to the soils considered past management actions taken prior to plan implementation and anticipated actions taken by the alternatives for the first 10 years including watershed condition improvement work.

Table 3A4-3. Cumulative Effects to Soil Productivity by GWNF Forest Plan Alternatives over first 10 years of the Plan, acres

Effects to Soil Productivity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Cumulative Long-Term Effects*	6,754	6,653 – 6,983	6,118	7,036 – 7,556	6,688 – 6,968	6,476 – 6,716	6,688-7,018	6,668 – 7,018
Cumulative Improved Soil Productivity***	1,378	1,547	1,823	1,362	1,647	1,593	1,647	1,647
Adjusted Cumulative Long-Term Effects	5,376	5,106 – 5,436	4,295	5,674 – 6,194	5,041 – 5,321	4,883 – 5,123	5,041-5,371	5,041 – 5,371
Percent of the GWNF Activity Areas** with Long-Term Effects after 10 yr	0.53%	0.51-0.54%	0.68%	0.56-0.61%	0.50-0.53%	0.54 – 0.56%	0.50 – 0.54%	0.51 – 0.54%

*Cumulative Long-Term Effects generated by alternative actions plus Existing Long-Term Effects.
**Activity Area explained in the Scope of Analysis section above.
*** Decommissioned roads and watershed improvement project acres.

A5 – AIR

AFFECTED ENVIRONMENT

The 1977 and 1990 Amendments to the Clean Air Act (CAA) afford special protection from air pollution to designated Class I areas. The George Washington National Forest (Forest) does not manage any Class I areas, however James River Face Wilderness, managed by the Jefferson National Forest, is adjacent to the Forest to the south. Other Class I areas near the George Washington National Forest are the Shenandoah National Park, and Dolly Sods and Otter Creek Wildernesses on the Monongahela National Forest. The Prevention of Significant Deterioration section of the Clean Air Act (CAA) requires Federal Land Managers to identify Air Quality Related Values (AQRV), or resources important to the Class I areas that might be affected by air pollution. For the Class I areas near the Forest these include visibility, water quality and vegetation. The term AQRV will be used broadly to apply to any resources within the Forest boundary that might be affected by air pollution.

Through a series of legislative and regulatory requirements, federal land management agencies have the unique responsibility to not only protect the air, land, and water resources under their respective authorities from degradation associated with the impacts of air pollution emitted outside the borders of Agency lands (Clean Air Act 1990), but to protect those same resources from the impacts of air pollutants produced within those borders (Clean Air Act 1990, Organic Act 1977, Wilderness Act 1997). Activities from within the forest such as prescribed burning, road construction/maintenance, oil and gas development, recreational use, and timber harvesting all have an impact on the air quality of the forest. It is the responsibility of federal land managers to minimize the impact of these activities on the forest's AQRV, as well as the forest's contribution to air pollution. In light of this responsibility, it is important for federal land managers to understand the impacts of pollution from activities within the National Forest, and also to be familiar with the impacts from pollution sources outside the forest boundary.

The George Washington National Forest is located in an area of the United States that continues to grow in population with an associated demand for electricity and transportation. The Forest is located downwind of two major areas of coal-fired power generation, the Ohio River Valley and the Tennessee Valley Authority; and within a day's drive of a large percentage of the United States population and numerous major cities. Washington DC and Richmond are among the larger urban areas within 125 miles of the Forest. The heavily traveled Interstate Highway 81 runs the length of the Forest. Nitrogen oxide, sulfur dioxide and fine particulates are the main pollutants emitted from these sources that are affecting resources on the Forest.

Nitrogen oxides are an important contributor to the formation of ground-level ozone on hot sunny days (Chameides and Cowling 1995). The Forest operates an ozone monitor at the Glenwood/Pedlar District office in cooperation with the Virginia Department of Environmental Quality (VDEQ). Data collected since 1999 indicates this area is currently in compliance with the one-hour and 8-hour ozone National Ambient Air Quality Standards (NAAQS). The NAAQS are regularly reviewed and modified by EPA, and a reduction in the ozone standard is expected in the fall of 2013. Final attainment/nonattainment decisions will be made sometime in the future and will be based on monitoring data that has not yet been collected. However, current ozone concentrations at monitors near the Forest exceed at least the most stringent proposed 8-hour ozone NAAQS (Figure 3A5-1 - 2009 AQ Report to Forest). There is also a proposed secondary ozone standard in the form of a seasonal exposure index, W126; a measurement that recognizes the cumulative impacts that ozone concentrations have on sensitive vegetation. Recent monitoring results show that some sites could exceed the proposed secondary NAAQS, indicating pollution levels high enough to be harmful to vegetation.

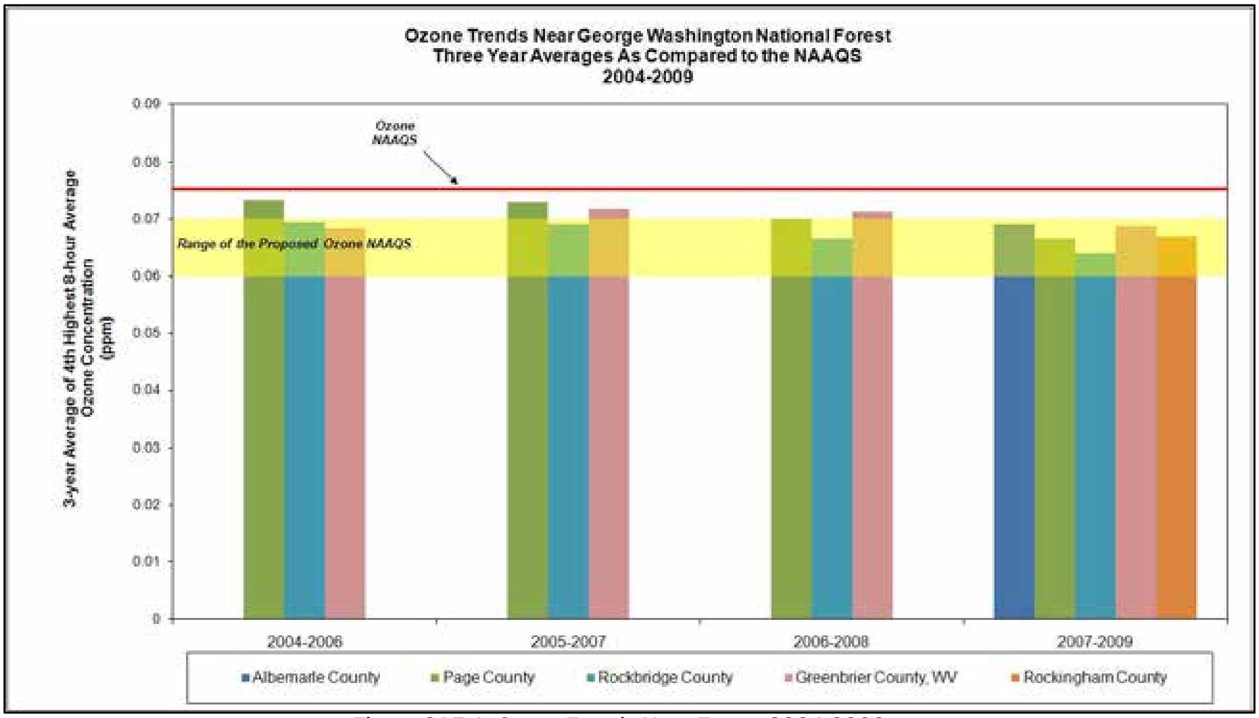


Figure 3A5-1. Ozone Trends Near Forest 2004-2009

About a third of nitrogen oxides affecting the Forest are from power plants (especially during hot summer days when electricity is needed to cool homes and businesses), and another third are from highway vehicles. The rest are from industrial sources.

Laws, rules, and regulations are in place that are resulting in lower nitrogen oxide emissions in Virginia and neighboring states. Annual NO_x emissions from sources in Virginia and West Virginia have declined 68 percent from 2000 levels (about 147,000 to 47,000 tons in 2008) and 76 percent from 1990 levels (200,000 tons) (EPA 2008). These reductions have resulted from implementation of the Acid Rain Program and the NO_x Budget Trading Program. Further nitrogen oxide reductions are anticipated as State and local air pollution control agencies seek ways to attain new ozone standards in urban areas near the Forest, and in cities to the south and west of the Forest. These further reductions in nitrogen oxides will benefit the health of people visiting or living within the Forest, as well as the vegetation.

Acid compounds in clouds, fog, rain and haze are having an adverse impact on visibility and the ability of the soils and streams to buffer acid inputs. Further discussion of the current effects of acid deposition on aquatic resources can be found in the Water Resources and the Fisheries and Aquatic Habitats Sections. Sulfates (sulfur compounds that originate from sulfur dioxide) are the predominant pollutants causing these impacts. Approximately 80% of the sulfur dioxide emissions affecting the Forest are released from coal-fired power plants. Power plants in the Ohio River Valley, Virginia, and West Virginia are most likely to be influencing the acidity and sulfate concentration of rainfall on the George Washington National Forest (SAMI 2002). However, as a result of Title IV of the Clean Air Act Amendments of 1990 (the Acid Rain Program) and the 1999 Regional Haze Rules, power plants throughout the United States, including those near the George Washington National Forest, have installed pollution control devices to reduce emissions of sulfur dioxide and other pollutants that cause acidic deposition such as nitrogen oxides. Emissions of sulfur dioxide declined by roughly 50% between 2005 and 2009 (EPA CAMD), with about half of that reduction occurring in 2009. Part of the emissions decline is attributed to reduced energy demand in 2009 related to the recession. Additional emission reductions are expected in the future as the provisions of the Regional Haze Rule are implemented, as discussed below.

With the reduction of sulfur dioxide and nitrogen oxide emissions, sulfate and nitrate deposition has also decreased, as would be expected. Wet deposition monitors located near the Forest show that annual sulfate

deposition was about 8 kg/ha in 2009; down from about 15 kg/ha in 2000. Even though sulfur deposition is decreasing, acid neutralizing capacity, or the stream's ability to buffer acid inputs, is predicted to continue to decrease in high elevation headwater streams (SAMI 2002; Sullivan et al. 2010). This happens because most soils on the Forest continue to retain at least part of the sulfur that is deposited. Even though sulfur deposition may decrease, soils have been retaining sulfates that will continue to be released and move out of the soil into the stream water. As sulfates are released into the soil water, base cations, such as calcium, may also be removed from the soils. Removal of calcium and other base cations can lead to nutrient depletion and a reduction in soil productivity.

The beautiful mountain scenery is one of the reasons tourists visit the George Washington National Forest and other areas in Appalachia. However on many days of the year a uniform haze-like white or gray veil obscures the scenery. In 1997 Congress determined that all Class I areas in the nation were suffering from some level of visibility impairment; that there has been a significant reduction in how far a person can see distant views, as well as the clarity of that view. The estimated natural background visibility for the eastern United States is 93 ± 28 miles (NAPAP 1991) and median visibility measured at James River Face Wilderness in 2008 was only 38 miles. While this still represents impairment from the natural condition, it is an improvement over the median visibility in the late 1990s of 26 miles. Median visual range at Shenandoah National Park has been improving as well and was about 47 miles in 2008. This improvement in visibility is a direct result of emissions reductions achieved through the Acid Rain program and other efforts. Further reductions are expected as the Regional Haze State Implementation Plans are adopted and implemented (Virginia Regional Haze State Implementation Plan, 2010). The Regional Haze SIP sets goals for improving the worst visibility conditions while preserving the clearest conditions.

Regional haze and reduced visibility observed in the mountains is caused mostly by air pollution, primarily sulfates that originate from coal-fired power plants. The fine particles ($PM_{2.5}$) primarily responsible for visibility impairment are formed when combustion gases are chemically transformed into particles. In the eastern United States, sulfate particles (transformed sulfur dioxide) from coal-fired power plants comprise the largest component of measured fine particle mass (IMPROVE 2001) affecting visibility. The clearest days in 2008 at James River Face had 69 miles visibility and the lowest fine particle mass (4.48 ug/m3). The days with the highest concentration of mass (16.31 ug/m3) showed visibility was reduced significantly to only 19 miles. The days with the poorest visibility are most likely to occur starting in May and continue through September (http://views.cira.colostate.edu/web/Trends/), during the time when most people are visiting the Forest. Sulfates are still the most important fine particles contributing to visibility impairment. On the clearest days they comprise 30% of the total mass while on the haziest days the sulfates are 38% of the total. Organics (released primarily from vegetation as volatile organic compounds) are the second most important fine particles measured, and if organics were the most abundant particulate species, then there would be a bluish cast to the mountains, hence the name Blue Ridge Mountains.

The fine particles that cause visibility impairment can also be unhealthy for people, because high concentrations aggravate respiratory conditions, such as asthma. Fine particles are closely associated with increased hospital admissions and emergency room visits for heart and lung disease, increased respiratory disease and symptoms such as asthma, decreased lung function, and even premature death (EPA 1997). Sensitive groups at greater risk include the elderly, individuals with cardiopulmonary disease, and children. For this reason, fine particle levels are monitored. Monitoring results for fine particulates include both primary particulate (that are emitted directly from a source) and secondary particulate (resulting from transformation of gases in the atmosphere). The Environmental Protection Agency has established NAAQS for fine particles ($PM_{2.5}$) based on three-year averages of monitored data. Monitors near the Forest indicate that both the annual average $PM_{2.5}$ and the 24-hour average standard are not exceeded (Figure 3A5-2 - 2009 Air Quality Report for the George Washington and Jefferson National Forests), however EPA is required to reassess the standards every few years and proposal of a more stringent standard is anticipated.

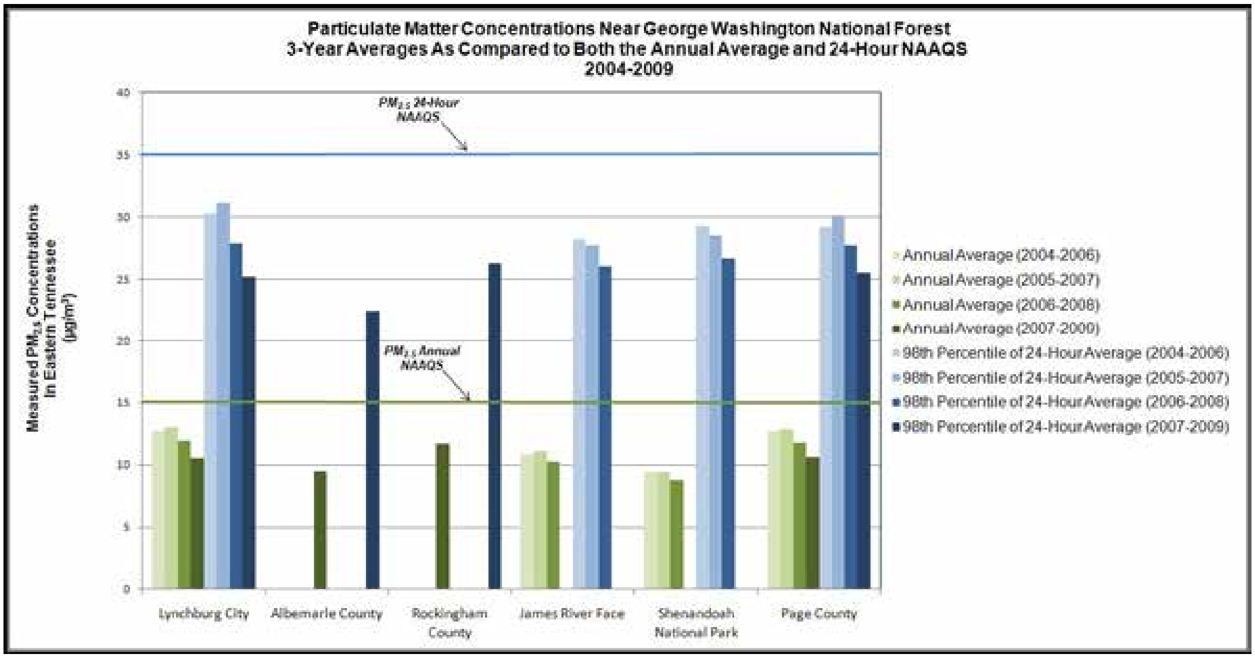


Figure 3A5-2. Particulate Matter Concentrations Near the Forest 2004-2009

The Environmental Protection Agency will ultimately decide if any other areas affecting the Forest will be designated as non-attainment for fine particles or ozone. It is of particular importance for fire managers to mitigate prescribed fire emissions, to the greatest extent practical, during those days characterized by existing or predicted high ambient air pollution. The $PM_{2.5}$ standard may require fire managers to be even more vigilant in smoke management to protect the health and welfare of citizens on and off Forest lands from the effects of particulate matter emissions associated with prescribed fire.

Once an area is designated non-attainment, a State Implementation Plan (SIP) is developed in an attempt to bring the area back into attainment of the standard. This usually involves placing controls on various sources that contribute to the pollutant of concern in order to lessen or minimize their emissions. SIPs are developed based on emission inventories of contributing sources of pollution. Considering that 70% of the particulate emissions from prescribed fires are fine particles, and nitrogen oxides and volatile organic compounds are also released, state air regulators will be interested in these emissions. The Forest will need to continue to interact closely with the Virginia Department of Environmental Quality to ensure that Forest prescribed fire emissions (and perhaps other Forest activities) are accurately considered in State Implementation Plan development.

DIRECT AND INDIRECT EFFECTS

As an ecological process, wildland fire is essential in creating and maintaining functional ecosystems and achieving other land use objectives. However, smoke is a byproduct of prescribed fire that affects air quality. All emissions from wildland fires are generated from the incomplete combustion of fuel, and include: particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides and hydrocarbons (Hardy et al. 2001). The single-most important emission in smoke is fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) because it limits visibility, absorbs harmful gases, and aggravates respiratory conditions in sensitive individuals. Fine particulates ($PM_{2.5}$) make up more than 70% of the mass of particulate matter produced by wildland fire. Environmental Protection Agency (EPA) routinely reviews air quality standards for ozone and $PM_{2.5}$ and adopts more stringent standards to protect human health, if research indicates this is necessary. In 2006 the $PM_{2.5}$ standard was reduced, and lower ozone standards are expected to be finalized in 2014. The challenge in using wildland fire is balancing the public interest objectives of protecting human health and welfare (from air pollution) and sustaining ecological integrity. The EPA recognizes this challenge and developed an interim air quality policy on wildland and prescribed fires with the public policy goal to allow fire

to function as much as possible in its natural role in maintaining healthy wildland ecosystems, and to protect public health and welfare by mitigating the impacts of air pollutant emissions on air quality and visibility (EPA 1998).

In order to minimize the negative effects of smoke and associated pollutants on human health and visibility, smoke management plans are a required part of every prescribed fire burn plan. The negative effects of smoke can be reduced by planning and executing prescribed fires on days that maximize smoke dispersion and avoid smoke-sensitive areas. For each prescribed burn conducted, the Forest Service determines smoke dispersion characteristics that must be met in the weather forecast for the day of the burn. These characteristics include: the depth of the atmosphere available for smoke mixing (dispersion), transport wind speed and direction, and the probability of air mass stagnation during the day. Forest Service smoke management guidelines include:

- Predicting smoke behavior for the weather conditions anticipated during the burn.
- Determining if there are smoke-sensitive targets (public or private ownership) within the probable smoke impact area and coordinating with them to avoid or mitigate problems.
- Monitoring the actual weather conditions and smoke behavior to make sure the burn continues to be within the prescription.
- Being prepared to cease ignition and/or initiate suppression if the weather changes from the forecast and causes smoke behavior problems that cannot be mitigated.

Application of the precautionary and mitigation measures described above will limit the risk and severity of any problems that might occur from prescribed fire smoke.

Fine particulate emissions were estimated for each alternative and compared to current prescribed fire emissions and the background condition. Background condition is the fine particulate from all sources of primary fine particulate emissions within the counties containing national forest system lands. These counties are referred to as the "analysis area".

Direct effects on air quality were assessed by comparing $PM_{2.5}$ emissions estimates from each alternative to emissions from the current prescribed fire program. Emissions were calculated for the minimum and maximum number of planned acres in each alternative using best estimates of fuel type, fuel consumption and emissions rates. Actual acres burned in any given year, and resulting $PM_{2.5}$ emissions, will depend on weather conditions and other factors that must be considered prior to initiating a prescribed fire. Background $PM_{2.5}$ emissions are from the 2005 National Emissions Inventory (EPA 2005).

On average, the Forest has burned 5,800 acres annually since 2006, and estimated $PM_{2.5}$ emissions from this program would be 406 tons. Alternatives B, D, E, F, G, H and I propose increasing the use of prescribed fire which would result in an emissions increase of roughly 100 - 250 percent over current levels (Table 3A5-1). Alternatives A and C would actually use prescribed fire on fewer acres and result in less emissions than the current program.

Table 3A5-1. Annual Fine Particulate Matter ($PM_{2.5}$) Emissions by Alternative (compared to current fire program and inventoried background primary $PM_{2.5}$ emissions within counties containing George Washington National Forest system lands)

Alternative	Estimated Annual $PM_{2.5}$ Emissions, in tons		Percent Change in $PM_{2.5}$ Emissions: Direct/Indirect Effects: Alternatives Compared to Current Fire Program		Percent Change in $PM_{2.5}$ Emissions: Cumulative Effects: Alternatives Compared to All Other Sources	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
A	210	210	-48	-48	-2	-2
B	1,089	1,425	168	251	7	10
C	25	25	-94	-94	-4	-4
D	375	865	-8	113	0	5
E	1,448	1,448	257	257	10	10
F	865	1,425	113	251	5	10
G	865	1,425	113	251	5	10
H and I	865	1,425	113	251	5	10
Current Fire Program	406	406				

The largest prescribed fire program on the Forest occurred in 2009 when 9,526 acres were burned. $PM_{2.5}$ emissions that year were estimated at approximately 670 tons. Emissions from the minimum burn program for any proposed Alternative would be equal to or less than those in 2008. The maximum program for all alternatives, except E, would exceed the 2008 emissions by 20-65%.

CUMULATIVE EFFECTS

Emissions from prescribed fire are only one of many sources of $PM_{2.5}$ pollution. Fine particulates can be emitted directly into the atmosphere or can be created from gaseous pollutants that are chemically transformed into particulates (sulfur dioxide is transformed into sulfate particles). Only those particulates emitted directly into the atmosphere (primary pollutants) are tracked in emission inventories. The most recent emissions inventory available from the Environmental Protection Agency estimates primary $PM_{2.5}$ emissions within the analysis area at 10,067 tons (EPA 2005). Emissions from proposed Alternatives B, D, E, F, G, H and I could account for 5-10% increase in primary $PM_{2.5}$ emissions in the analysis area (Table 3A5-1). Alternatives A and C could result in a slight decrease (2-4%) in $PM_{2.5}$ emissions in the analysis area. In reality the changes in ambient $PM_{2.5}$, the pollution that people are exposed to, would be even less. This is because a large amount of monitored $PM_{2.5}$ is secondary particulate formed from gaseous pollutants such as sulfur dioxide. Secondary particulates are not included in the emission inventory. If they were, the contribution of emissions from prescribed fires would be reduced.

Another way to evaluate the cumulative effects of prescribed fire on air quality is to compare monitored fine particulate concentrations to prescribed fire emissions. Figure 3A5-3 (2009 Air Quality report to Forest) shows that although there were periods of increased prescribed fire emissions from 2005 through 2009, there was a decrease in monitored fine particulate concentration for both the annual and 24-hour averaging periods. This shows that local and regional $PM_{2.5}$ concentrations do not appear to be correlated with $PM_{2.5}$ emissions from prescribed fires on the Forest.

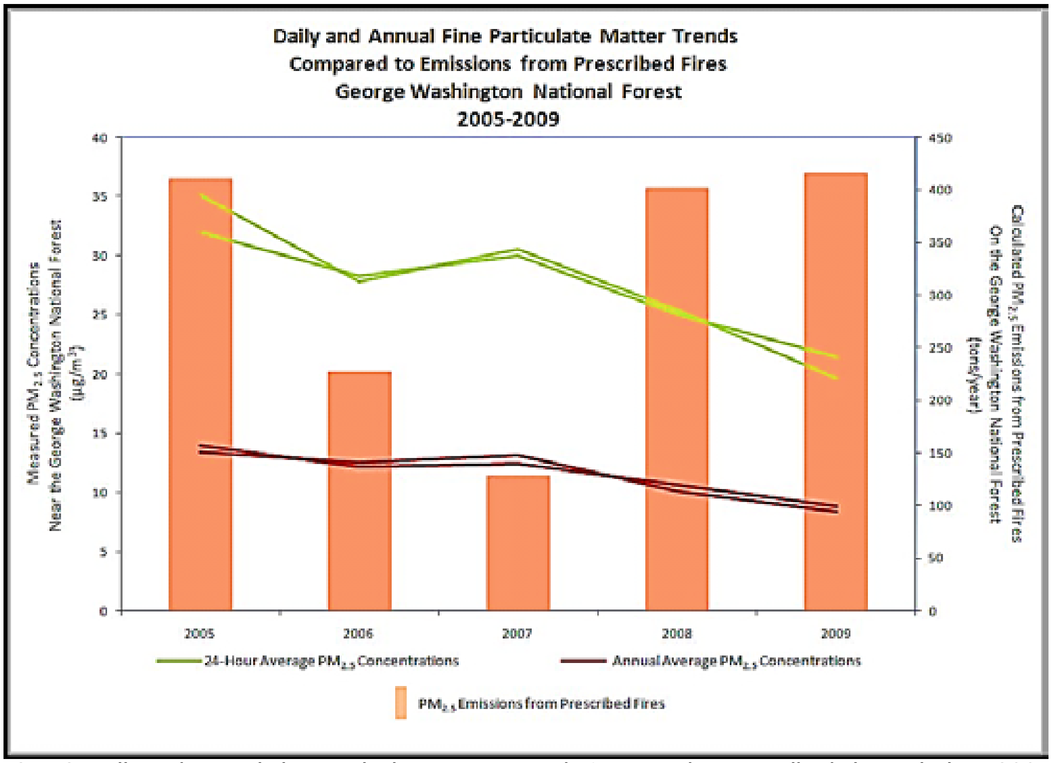


Figure 3A5-3. Daily and Annual Fine Particulate Matter Trends Compared to Prescribed Fire Emissions 2005-2009

The projected emissions from prescribed fires are not expected to be a large contributor to total fine particulate matter mass nor any exceedence of the fine particle National Ambient Air Quality Standard (NAAQS). However, the Forest will be expected to follow Conformity Determination rules and disclose any prescribed fire emissions for activities planned in designated non-attainment areas.

A6 – WATER

AFFECTED ENVIRONMENT

The Forest is almost equally divided between the Potomac and James River basins. Tributaries of the Potomac in the vicinity of the Forest include South Fork South Branch of the Potomac and the Lost, Cacapon, Shenandoah (North and South forks), Dry, North, and Middle Rivers. Rivers tributary to the James include the Jackson, Bullpasture, Cowpasture, Calfpasture, Maury, South, St. Mary's, Pedlar, Buffalo, and Tye.

National forest system lands are typically the mountainous headwaters in each of these systems. As such, the streams on the national forest are typically small high-gradient, high-energy systems. Water yield for the Forest averages 16.6 area-inches per year. This is not distributed uniformly in time or space. Based on streamflow information from the U.S. Geological Survey stream gauging stations, the average annual runoff from the Forest varies from approximately 11 area-inches to over 27 area-inches.

Streamflow represents a "leftover" of precipitation minus evaporation and water use by growing vegetation. As such, it is extremely variable. Streamflow varies by year and by time of year. May and July are the months most likely to have the highest precipitation. However, in a typical year, March is the month with highest streamflows. This occurs because the high precipitation months are also during the growing season when much of the precipitation is used by vegetation. Streamflows are typically lowest in late summer and early autumn at the end of the growing season. January and February are the months with lowest precipitation.

Floods and Droughts

The watersheds of the George Washington National Forest periodically experience extreme flow events. Virginia lies in the path of cyclone storms that originate in the Gulf of Mexico and the Atlantic Ocean and carry large amounts of moisture. Flooding is common in the state, especially in the western mountain regions, where high precipitation and steep topography produce rapid runoff. The lands of the Forest have been touched by floods of magnitude greater than 50 year recurrence interval in 1936, 1942, 1949, 1969, 1972, 1985, and 1996. Most of these were produced by hurricanes. The potential for flooding is greatest when soils are near saturation as they are in the spring or at any time of year following several days of rain. The presence of a forest canopy in a watershed can reduce flood peaks from small-to-moderate storms during the growing season because the growing trees utilize soil moisture and transpire it to the atmosphere. This soil moisture difference becomes negligible during large-storm events. Thus forest harvesting has no substantive effect on large floods (Hewlett 1982; Eisenbies et al. 2006).

A small mountain watershed on the George Washington National Forest can produce flood peaks approaching 1,000 cubic feet per second, per square mile. In contrast, a larger river basin like the James River at Holcomb Rock will have a maximum peak discharge of only 50 cubic feet per second, per square mile.

Low flows typically occur during late summer and early autumn when precipitation is low and soil moisture is utilized by growing vegetation. Water in the stream represents the release of water from groundwater and soil storage. Because of the wide range in topography, rock types, and soils, there is a wide variation of low flows in the streams of the George Washington National Forest. Where soils are deep, slopes are gentle, and drainage density is low, precipitation can be stored within the watershed and released slowly. Thus, peak flows are moderated and low flows are sustained. As greater flow contributions are from groundwater, water temperature is usually lower and less variable. Based on years of data from USGS stream gages across the Forest, low flows are higher in the Blue Ridge.

Water Quality

Water quality on the George Washington National Forest is affected by nonpoint sources of pollution that can affect the physical, chemical, or biological integrity of Forest streams. Collectively, these factors make up the water's aquatic ecological integrity. Nonpoint sources of pollution on the Forest can include road construction and maintenance, timber harvest, dispersed and developed recreation management, and fisheries and wildlife habitat improvement. The largest potential impact on water quality from our management activities is from an

increase in sediment in streams which can affect the physical integrity of streams. Monitoring has not been conducted to characterize stream condition or trend relative to sediment from management activities. Activities off the Forest are affecting the chemical integrity of Forest streams. Acid deposition from industry and automobiles are causing many streams to become more acidic. See the discussion in the Fisheries and Aquatic Habitat section. A more extensive monitoring program is underway to characterize the chemistry and stream insects of most of the Forest's streams.

Impaired Waters

The 2010 303d reports for Virginia and West Virginia list 56 streams and 4 reservoirs on the Forest as being impaired. The sources of these impairments are off-Forest (including acid deposition), or are described as "natural." None of the impairments are attributed to Forest management activities.

Table 3A6-1. Impaired Waters on the George Washington National Forest

Water Name	Cat.	Use	Impairment	Source
Pedlar River	5A	Recreation	E. coli	Non-point source (NPS)
Big Run	5A	Recreation	E. coli	Agriculture, NPS, wildlife
North River	5A	Aquatic Life	pH	Atmospheric deposition
Thorny Branch	4A	Recreation	Fecal coliform	Non-point source
Briery Branch	5C	Aquatic Life	pH	Natural conditions
Narrow Passage Creek	5A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Cedar Creek	5A	Aquatic Life	Benthic macro bioassessments	Unknown
Loves Run	5A	Aquatic Life	pH	Atmospheric deposition
Pine Run	4A	Recreation	E. coli	NPS, wildlife
Back Creek [Augusta Co.]	5A	Aquatic Life	Benthic macro bioassessments	Unknown
South Fork Shenandoah R	5A	Fish Consumption	Mercury in fish tissue	Contaminated sediments
North Fork Shenandoah R	5A	Aquatic Life	Benthic macro bioassessments	Non-point source
Crab Run	5A	Recreation	E. coli	Agriculture, NPS, wildlife
Shoemaker River	4A	Recreation	E. coli	Agriculture, NPS, wildlife
Runion Creek	4A	Recreation	E. coli	Agriculture, NPS, wildlife
Sours Run	4A	Recreation	E. coli	Agriculture, NPS, wildlife
Falls Hollow	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Tunnel Hollow x-trib	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Beaver Creek	4A	Recreation	Fecal coliform	NPS, wildlife
Beaver Creek	4C	Aquatic Life	Temperature	Natural conditions
Rocky Run	5A	Aquatic Life	pH	Atmospheric deposition
Union Spring Run	5A	Aquatic Life	pH	Atmospheric deposition
Wolf Run	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Wolf Run	5A	Aquatic Life	pH	Atmospheric deposition
Dry River	5A	Aquatic Life	pH	Atmospheric deposition
Skidmore Fork	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Coles Run	5A	Aquatic Life	pH	Atmospheric deposition
Johns Run	5A	Aquatic Life	pH	Atmospheric deposition
Kennedy Creek	5A	Aquatic Life	pH	Atmospheric deposition
Mills Creek	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Orebank Creek	5A	Aquatic Life	pH	Atmospheric deposition
Toms Branch	4C	Aquatic Life	Benthic macro bioassessments	Drought-related impacts
Cub Run [Elkton W quad]	5A	Recreation	Fecal coliform, E. coli	Agriculture, NPS, wildlife
Boone Run	5A	Recreation	Fecal coliform	NPS, wildlife

Water Name	Cat.	Use	Impairment	Source
Little Dry River	4A	Recreation	Fecal coliform	NPS, wildlife
Little Dry River	5A	Aquatic Life	pH	Atmospheric deposition
Fridley Run	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Fridley Run	5A	Aquatic Life	pH	Atmospheric deposition
Mountain Run	4A	Recreation	Fecal coliform, E. coli	Agriculture, NPS, wildlife
Mountain Run	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Mill Creek [R'ham Co.]	4A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Mill Creek [R'ham Co.]	4A	Aquatic Life	Benthic macro bioassessments	Unknown
Laurel Run [Shen Co.]	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Little Stony Creek	5A	Aquatic Life	Benthic macro bioassessments	Atmospheric deposition
Stony Creek	4A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Stony Creek	5A	Aquatic Life	Benthic macro bioassessments	Agriculture, NPS, wildlife
Stony Creek	5A	Aquatic Life	Temperature	Unknown
Passage Creek	5A	Recreation	Fecal coliform	Agriculture, NPS, wildlife
Passage Creek	5A	Aquatic Life	pH	Atmospheric deposition
Jackson River	5C	Aquatic Life	Temperature	Natural conditions
Jackson River	5A	Recreation	E. coli	NPS, wildlife
Back Creek [Bath Co.]	5A	Aquatic Life	Temperature	Unknown
Laurel Run [Bath Co.]	5A	Aquatic Life	pH	Atmospheric deposition
Panther Run	4C	Aquatic Life	Benthic macro bioassessments	Drought-related
Pheasanty Run	4A	Aquatic Life	Benthic macro bioassessments	Aquaculture (permitted)
Porters Mill Creek	5A	Aquatic Life	pH	Atmospheric deposition
South Fork Pads Creek	4C	Aquatic Life	Benthic macro bioassessments	Drought-related
Calfpasture River	5A	Recreation	E. coli	Agriculture, NPS, wildlife
Little Calfpasture River	5A	Recreation	Fecal coliform	NPS, wildlife
Saint Mary's River	5A	Aquatic Life	pH	Atmospheric deposition
Irish Creek	5A	Aquatic Life	Temperature	Unknown
Wilson Creek	5C	Aquatic Life	Temperature	Drought-related impacts; unknown
Potts Creek	5A	Recreation	E. coli	Livestock, septic systems, wildlife
Potts Creek	5C	Aquatic Life	pH (> 9.00)	Unknown
Coles Run Reservoir	5A	Aquatic Life	pH	Atmospheric deposition
Elkhorn Lake	5A	Aquatic Life	Temperature	Unknown
Staunton Dam Lake	5A	Aquatic Life	pH	Atmospheric deposition
Switzer Lake	5A	Aquatic Life	pH	Atmospheric deposition
Switzer Lake	5A	Aquatic Life	Temperature	Unknown
Capon Run	5		Biological	Unknown
Hawes Run	5		Biological	Unknown
Miller Run	5		Biological	Unknown

Category 4A - water is impaired or threatened for one or more designated uses; TMDL has been completed.
Category 4C - impairment is not caused by a pollutant and/or is caused by natural conditions; no TMDL is required.
Category 5A - water is impaired or threatened for one or more uses by a pollutant(s); TMDL is required.
Category 5C - water quality standard is not attained due to "suspected" natural conditions; may require a TMDL; WQ Standard may be reevaluated due to the presence of natural conditions.
Category 5 - water is impaired, and a TMDL is needed (West Virginia).

The 2010 Water Quality Assessment for Virginia lists 69 impairments on the Forest, affecting 53 streams and four reservoirs. For 11 of the stream impairments, the cause is a natural condition, and no Total Maximum Daily Load (TMDL) allocation is required; or the cause is a "suspected" natural condition, and a TMDL may or may not be required. For an additional 18 stream impairments, the source is atmospheric deposition.

For all the other 33 stream impairments, much more of the stream's length is on private land than on Forest Service land, and almost all the samples on which these impairments were based were collected miles downstream from Forest Service land. The predominant sources for these impairments are agriculture, nonpoint sources, and wildlife. For six impairments, the source is listed as unknown.

TMDL reports have been completed for twelve of the impairments. One deals with aquaculture. The other eleven, which are for bacteria, identify agriculture as the main source of pollution, with wildlife as a secondary source. None of these TMDL reports identify activities related to forest management as a significant source.

For Coles Run Reservoir, Staunton Dam Lake, and Switzer Lake, the impairment is low pH, due to atmospheric deposition. Elkhorn Lake and Switzer Lake are also listed with a temperature impairment, with the source being unknown.

The 2010 West Virginia Integrated Water Quality Monitoring and Assessment Report lists three impaired streams that are on the Forest: Capon Run, Hawes Run, and Miller Run. For all of these streams, the criterion affected is biological, the source is unknown, and a TMDL is needed. For each of these, most of the stream's length is on private land, and the impairment cannot be attributed to Forest management activities.

Drinking Water

Water quality in streams is a priority on the National Forest. Since 1988, almost 6,000 water samples have been analyzed from George Washington and Jefferson National Forest streams. Some streams have been part of a long-term monitoring program and are sampled quarterly; others have had only one or two samples taken to characterize their chemical habitat. In response to concerns over the quality of water from the George Washington National Forest related to drinking water, Virginia water quality standards (State Water Control Board 2008) were compared to 5,532 water samples collected from streams on the national forest. To get a complete picture related to the public water supply water quality standards, measurements from both the George Washington and Jefferson National Forests, during all seasons, and all years were included in the analysis.

There are three chemical parameters listed in the Virginia Water Quality Standards (VA WQS) that have been sampled consistently across the Forests; they are chloride, nitrate, and sulfate. A box and whisker plot was developed for each of these parameters from the National Forest dataset; in addition, the VA WQS was shown as a horizontal bar in the charts. The top and bottom of the boxes in the plots represent the 25th and 75th percentiles (50% of all values fall within the box), the bar in the center of the box represents the median, whiskers represent the 10th and 90th percentiles (80% of all values fall within the whiskers), and closed circles represent the entire range of the data.

As seen in Charts 1-3, none of the 5,532 samples exceeded VA water quality standards for public water supply. In fact, as shown by the box, 90% of the samples are far below the water quality standard threshold.

Chart 1. Chloride measurements from 5,532 stream water samples taken on the GWJ National Forest related to the VA water quality standards for public water supply.

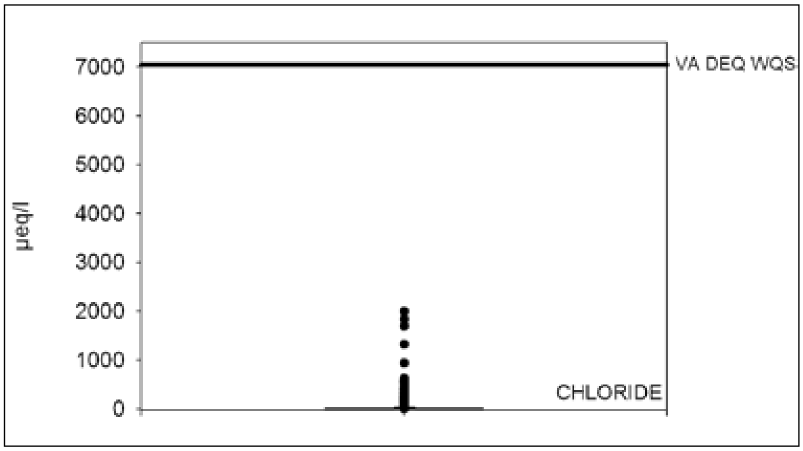


Chart 2. Nitrate measurements from 5,532 stream water samples taken on the GWJ National Forest related to the VA water quality standards for public water supply.

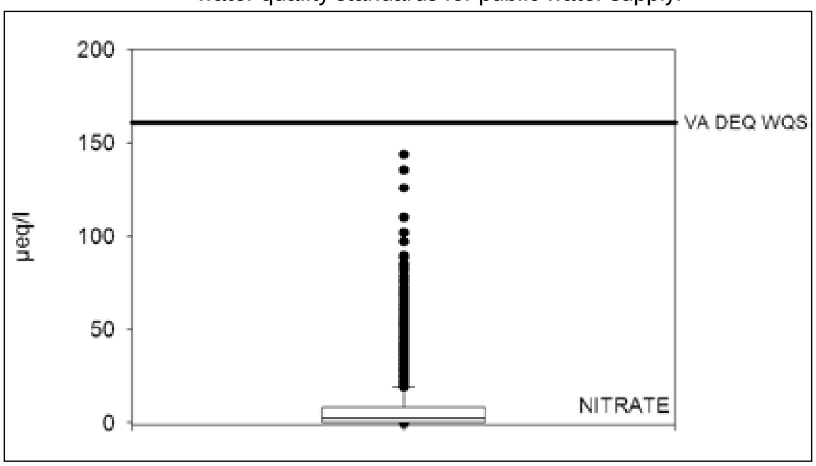
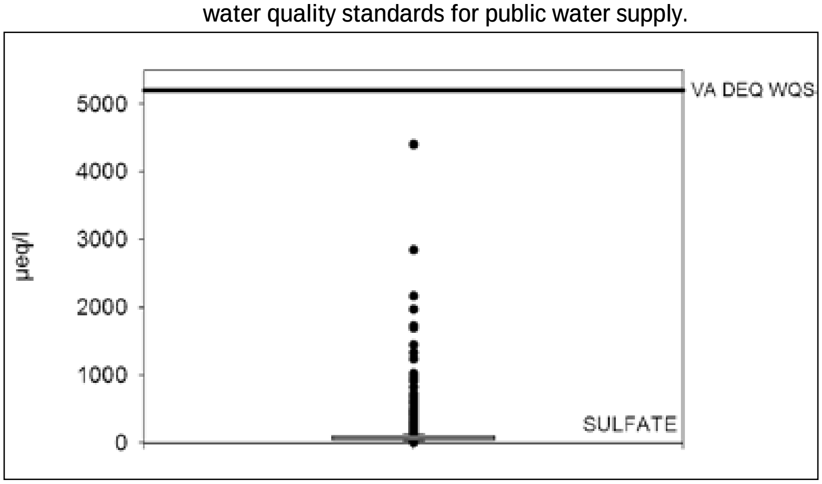


Chart 3. Sulfate measurements from 5,532 stream water samples taken on the GWJ National Forest related to the VA water quality standards for public water supply.



Reference: 2008. STATE WATER CONTROL BOARD. 9 VAC 25-260 Virginia Water Quality Standards. Statutory Authority: § 62.1-44.15 3a of the Code of Virginia. WITH AMENDMENTS EFFECTIVE October 2008

Outstanding National Resource Waters

Other streams are recognized for their high quality waters. As part of the anti-degradation provisions of Virginia water quality standards, waters which constitute an outstanding national resource or waters of exceptional recreational or ecological significance are designated as “Tier III” waters. Currently, there are 14 Virginia streams on the Forest that have been so designated: Brown Mountain Creek, Laurel Fork, North Fork of the Buffalo River, Pedlar River, Ramsey’s Draft, Blue Suck Branch, Downy Branch, North Branch Simpson Creek, Roberts Creek, Shady Mountain Creek, Cove Creek, Little Cove Creek, Rocky Branch, and North River. In West Virginia, all high quality waters or naturally reproducing trout streams located within national forests are designated Tier III waters. There are 13 of these streams on the Forest: Capon Run, Lower Cove Run, Waites Run, Trout Run, Hawks Run, Lick Run, Kettle Creek, Rough Run and an unnamed tributary, Stony Run, Road Run, Hawes Run, and Little Fork.

Water Uses

Water on the George Washington National Forest is needed for recreation, wildlife, domestic livestock watering, and administrative uses by the Forest Service. Additionally, instream flow quantities and timing are necessary to maintain the capacity of the channels to transport water and sediment, for fisheries, recreation, and visuals. Water sources on the Forest and adjacent to it are utilized for individual water supplies. Individual supplies for human consumption generally come from shallow-drilled wells or springs.

About 6 billion gallons of water per year are withdrawn directly from the Forest for municipal uses. Another 6 million are withdrawn for use at Forest recreation areas and administrative sites. These uses are about 1.3 percent of the Forest’s water yield. Additional water is withdrawn farther downstream.

Numerous communities withdraw drinking water from streams and reservoirs on the Forest or from rivers downstream from the Forest. The Virginian Water Quality Standards designate as Public Water Supplies the following waters that are at least partially on George Washington National Forest land:

- Coles Run from Augusta County’s raw water intake to its headwaters
- Dry River from Harrisonburg’s raw water intake to a point 5 miles upstream
- North River from Staunton Dam to its headwaters
- North Fork Shenandoah River and its tributaries from the Winchester raw water intake to points 5 miles upstream (to include Cedar Creek and its tributaries to their headwaters)
- North Fork Shenandoah River and its tributaries from Strasburg’s raw water intake to points 5 miles upstream
- North Fork Shenandoah River and its tributaries from Woodstock’s intake to points 5 miles upstream
- Pedlar River and its tributaries from Lynchburg’s raw water intake (near Lynchburg Reservoir) to points 5 miles upstream
- Smith Creek and Clifton Forge Reservoir from Clifton Forge’s raw water intake to their headwaters
- Jackson River and its tributaries from Covington’s raw water intake to points 5 miles upstream

Five water supply reservoirs are located in the George Washington National Forest:

- Coles Run Reservoir
- Switzer Lake (located seven miles upstream from Harrisonburg’s intake)
- Clifton Forge Reservoir
- Staunton Reservoir
- Lynchburg Reservoir

Additional downstream drinking water supplies were noted in comments. These have intakes on rivers in the vicinity of the Forest, and their watersheds are partially within the Forest:

- Broadway (North Fork Shenandoah River)
- Food Processors Water Cooperative Inc. (North Fork Shenandoah River)
- Front Royal (South Fork Shenandoah River)
- Harrisonburg (North River)
- Bridgewater (North River)
- Lynchburg (James River)
- Amherst (Buffalo River)
- Maury Service Authority (Maury River)

Areas upstream of all of these drinking water supplies were identified in comments, and total approximately 425,874 acres of George Washington National Forest land. In reality, the entirety of the Forest is encompassed in watersheds of rivers from which drinking water is withdrawn downstream (e.g., the James and Potomac Rivers).

Groundwater

In 2006 the Forest Service established new direction for ground water resource management, with an objective (FSM 2882.02) to: Protect, manage, and improve ground water and ground-water dependent ecosystems, recognizing their unique values, while implementing land management activities. Ground Water-dependent Ecosystems (GDEs) are communities of plants, animals, and other organisms whose extent and life processes are dependent on access to or discharge of ground water in areas such as:

- Springs, seeps and wetlands
- Ground water-fed streams/lakes and associated riparian areas
- Shallow water table areas
- Cave and karst systems

Groundwater-dependent Ecosystems relating to biological resources are discussed in biological sections of Chapter 3. This section focuses on groundwater.

The groundwater resources of the Forest vary depending on the different hydrogeologic characteristics of the physiographic provinces and associated bedrock and surficial deposits, such as alluvium and colluvium. Most of the Forest is located on the ridges in the Valley and Ridge Province, where the ridges are dominated by sandstone and shale (Devonian, Silurian, and Mississippian); limestone, such as the Helderberg group, occurs less commonly. The Forest valleys in this Province are dominated by limestone or shale (deep aquifers) overlain by alluvium (shallow aquifers). Shale and sandstone generally are poor to fair groundwater producers. The carbonates are highly variable groundwater producers but where water has dissolved the rock into underground solution channels, the carbonates are moderate-to-large groundwater producers.

In the Valley and Ridge Province, geologic structures (fold, faults, and fractures) are important influences on the occurrence of groundwater. Hinkle and Sterrett (1978) in a groundwater study of Rockingham County noted, "Anticlines (up-folds in the rock strata) may bring good water-bearing beds near the surface along their axes and bury them along the flanks (Plate 5A). Similarly, synclines (down-folds in rock beds) may bring water-bearing units near the surface on the flanks or may cause them to descend to great depths along the axis (Plate 58)."

The Forest's Pedlar District is in the Blue Ridge Province, dominated by granitic bedrock except on the western flank underlain by quartzite, sandstone, and shale. Granitic bedrock generally has small amounts of good quality groundwater available from the fractured crystalline bedrock. The quartzite and other clastic bedrock (Chilhowee Group) are poor aquifers due to cementation. Catoctin Greenstone, a basaltic lava flow, along the crest of the Blue Ridge also is a poor water producer (Hinkle and Sterrett 1978).

Surficial deposits, such as alluvium, alluvial fans, and colluvium, are found in all the Physiographic Provinces, and may serve as aquifers as well as recharge zones to underlying bedrock.

Quality of groundwater varies depending on whether the well is drilled in shale, sandstone, granite, limestone, or surficial deposits. Most of the rural population near the Forest receives water supplies from groundwater. Since most of the population is in the valleys, most of the water wells are also in the valleys. The Forest generally is located in the sparsely populated mountains. So the few drilled wells on the Forest are primarily for recreation and administrative facilities. Because the Forest occupies the mountains above the valleys, the Forest is a part of the recharge area for groundwater in valleys.

The Forest has 21 active groundwater wells supplying water to recreation sites. Groundwater withdrawals range from about 40 gallons per day to 2,000 gallons per day. The Forest also has 9 inactive groundwater wells.

The Forest has 26 active special use authorizations for groundwater wells or springs supplying water to non-federal users, a mixture of public water supply districts and private users. For example, in 2002 the Forest issued a Permit for a groundwater well to a public water supply district; for the period 2007-2009 the annual pumpage (groundwater withdrawal) ranged from 34-41 million gallons per year. In 1996 commercial use of two springs for water bottling was authorized as part of a special use permit. The use of the two springs for commercial bottling or potable water was rescinded in 2009.

Requests for groundwater wells for public water supply on the Forest are expected to continue due to several factors: 1) State restrictions on use of springs as public water supply sources, 2) recognition of stress on reservoirs, streams, or other sources during periods of drought, 3) dam safety requirements and expenses, 4) increase in population in counties near the Forest. For example, in 2009 a public water service authority requested the Forest consider exploration and development of groundwater sources.

Groundwater in Karst

The Forest's groundwater resource that is most vulnerable to contamination is groundwater in karst geologic terrain underlain by carbonate bedrock (limestone and dolomite). Caves, sinkholes, and sinking streams are examples of openings in karst terrain that provide direct access for surface water to flow directly into the ground water. In karst terrain the flow of surface water into openings into the groundwater is a natural geologic process in the formation and development of karst terrain. Karst terrain where surface waters flow into sinkholes or disappearing streams is a groundwater recharge area. Karst terrain can also be groundwater discharge areas, such as where springs are present. A karst map with more discussion about karst is in Geology section.

Karst terrain and associated groundwater is widely distributed across the Forest and occurs on every Ranger District (Geologic Map Units Containing Karst figure in Geologic Resources section). These geologic map units indicate 11% of the Forest (about 119,000 acres) with geologic formations containing karst and karst-related groundwater.

Karst groundwater systems are complex, and are even more complex when surficial deposits, such as alluvial fans, mantle the karst bedrock. A notable example is the large alluvial fan along the Coal Road in the Maple Flats area on the north end of the Pedlar District. Thick deposits of sand and gravel overlie Shady dolomite in the Maple Flats sinkhole ponds area and create a complex karst groundwater setting. Another example of a complex karst groundwater setting is the Trout Pond Recreation Area on the Lee District where alluvial deposits overlie karst bedrock.

DIRECT AND INDIRECT EFFECTS

The following discussion provides some background information regarding the environmental effects common to soil and water resources from management activities. Any activity that disturbs the land surface, decreases

cover or alters vegetation can affect soils, water yield and water quality. The primary management activities that could affect the soil resource, water yield, and water quality are:

- Roads and Trails
- Vegetation Management
- Mineral Exploration and Development
- Fire Management
- Wind Energy Development

Roads and Trails. Roads and trails can directly and indirectly affect water by increasing sedimentation and concentrating runoff. Roads and trails can expose and compact soils, alter surface and subsurface water flow, and alter stream channels during construction. When left open they can contribute to higher erosion and sedimentation rates than closed roads and trails.

Vegetation Management. Vegetation management activities that typically affect soil and water are timber harvesting and associated landing and skid trail construction. Loss of the protective soil cover (litter) from ground disturbance can increase erosion and sedimentation while decreasing soil productivity. Water yield also increases because of reduced transpiration and raindrop interception.

Mineral Exploration and Development. Mineral exploration and development can affect soil and water by increasing erosion and sedimentation, soil compaction, and water yield. In many cases soil productivity is reduced and sediment can affect water quality. The potential seepage or spillage of toxic substances from mining facilities or disposal areas may also pose a threat to water quality. Effects of oil and gas exploration and development are discussed separately in Section D of this Chapter.

Fire Management. Prescribed burning directly affects soil and water by removing a portion of the vegetative cover, which exposes soil to erosion. Control lines also expose mineral soil. These factors can reduce soil productivity and increase stream sedimentation. The magnitude of effect varies widely depending on the soils, topography and the intensity of burn.

Wind Energy Development. Development of wind energy requires clearing the turbine sites, constructing or improving roads to the sites, and constructing power transmission lines. These activities can increase erosion and sedimentation and can concentrate runoff.

There is a great deal of variability in sediment yield from year to year, which is termed "interannual variability." In part, this is because sediment yield is much greater during high runoff years with more stormflow to erode and transport sediment. Conversely, sediment yield is much less during drought years when high flows may be less than bankfull. However, interannual variability is a function of much more than the weather.

Data from the USGS gage on the Rappahannock River at Remington provides an expression of the variability of annual sediment yield. For the 42 years with flow and sediment data, each year's percent difference from the long-term mean ranges from plus 184 percent to minus 82 percent. A change of annual sediment yield of plus or minus 60 percent represents one standard deviation from the long-term mean. This value is also termed the coefficient of variation. According to Bunte and MacDonald (1999), "very few records of annual sediment yield have a coefficient of variation of less than 50%, and most values are closer to 100%." Therefore, the data from the Rappahannock provide a good but conservative estimate of the coefficient of variation for watershed systems on the George Washington National Forest. Figure 3A6-1 displays the interannual sediment variability for the Rappahannock River at Remington.

The interannual variability of sediment determines the magnitude of change that can be detected during a given time period. Bunte and MacDonald (1999) state that the number of years of monitoring needed to detect a sediment increase of "z" percent at the 95% confidence interval is given by the formula:

$$\text{Number of sampling years} = \{(1.96/\text{"z"}) \times (\text{coefficient of variation})\}^2$$

This responds to the question of whether there will be a detectable change in the sediment load of any of the rivers considered in this analysis. For example, it would take at least 556 years of monitoring data to detect a 5 percent increase in sediment in the Rappahannock River or in other rivers in Virginia. For a sediment increase to be detectable, it would have to exceed the range of interannual variability for the watershed. According to the formula, it would require four years of annual sediment data to detect an increase of 59 percent at the 95% confidence interval, and more than a year to detect an increase of 100 percent. Sediment increases would have to exceed the interannual variability before they become reasonably detectable.

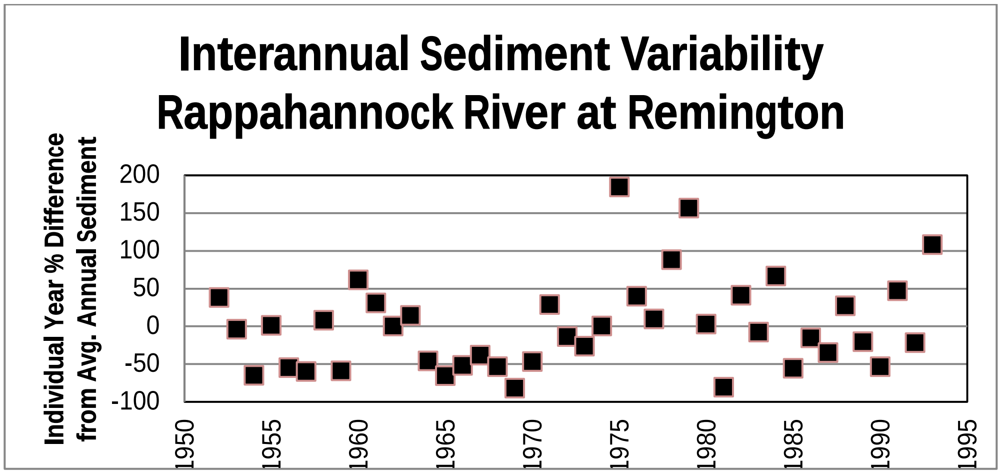


Figure 3A6-1. Interannual Sediment Variability Rappahannock River at Remington

Shorter sediment records from the James River at Buchanan and the South Fork Shenandoah River at Front Royal also show the high degree of variability in sediment yield from year to year (Table 3A6-2).

Table 3A6-2. Annual Sediment (tons), James River and South Fork Shenandoah River

River	1952	1953	1954	1955	1956
James River	198,056	214,575	157,450	378,870	41,028
South Fk Shenandoah			77,129	591,805	4,871

There are many difficulties associated with modeling sediment. Even the best of models have many limitations, and numerous assumptions must be made. The results will be, at best, within plus or minus 50% of the true value.

In view of the high interannual variability of sediment and the difficulty in accurately modeling sediment production, sediment, as such, will not be used as a measure of effects. Rather, acres of disturbance are used as a measure to indicate the relative effects of the alternatives on sediment and water quality (Table 3A6-3). Table 3A6-3 is based on prescribed fire levels of 3,000 acres in Alternative A, 7,400 acres in Alternative A[1], 12,000 acres and 5,000 acres in Alternative D, and 20,000 acres in Alternatives B, E, F, G, H and I. Timber harvest levels are based on levels generated by the Spectrum model and are 2,400 acres in Alternative A, 700 acres in Alternative A[1], 3,000 acres in Alternative B, 0 acres in Alternative C, 4,258 acres in Alternative D, 1,800 acres in Alternative E, 1,000 acres in Alternative F, and 3,000 acres in Alternatives G, H and I.

Table 3A6-3 Acres of Soil Disturbance by Alternative

Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
182	72	178 – 262	66	276 – 413	175 – 254	138 – 200	183 - 267	183 - 267

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Drinking Water

Alternative A specifies wider riparian areas when they are adjacent to or within one mile upstream of municipal water supply reservoirs.

In Alternatives B, D, E, F, G, H and I Public Water Supplies are identified. Public Water Supply watersheds are included among those watersheds that are a priority for restoration.

In Alternative C, management areas are assigned for drinking water watersheds as identified in comments. Drinking water watersheds are included among those watersheds that are priority for restoration.

In project implementation, the application of standards for the riparian management prescription and channeled ephemeral stream standards should fully protect drinking water quality. No measureable direct or indirect effects on water quality should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for implementation of standards and for effectiveness of standards.

Aquatic macroinvertebrates integrate the physical, chemical, and biological components of aquatic systems and have been successfully used as biological indicators of change and impacts. Aquatic macroinvertebrate monitoring is being used as an effective surrogate for monitoring sediment and other water quality parameters, thus providing an indication of the effectiveness of standards. A Macroinvertebrate Aggregated Index for Streams (MAIS) (range of scores 0-18) incorporates nine ecological aspects (metrics) of the aquatic macroinvertebrate community to evaluate the current condition of a stream relative to others within that ecological section (see the Aquatic Species Diversity section in this chapter). Pre-harvest MAIS scores were compared with post-harvest MAIS scores for 18 streams located below timber harvests at various locations across the Forest. There was no significant difference between the pre- and post-harvest MAIS score (USDA Forest Service, 2004).

Groundwater

Management activities that involve ground disturbance, such as construction of roads and developed recreation facilities, have the potential to adversely affect groundwater, particularly in karst geologic areas. All the alternatives have Forest Plan standards to protect the Forest's groundwater, including groundwater-dependent ecosystems. The Forest Plan standards to protect groundwater are in various sections of the Forest Plan, including Geologic Resources, Geologic Hazards, Water, Soil, and Caves. Standards under all alternatives provide that the location and design of management activities will evaluate measures to avoid, minimize, or mitigate adverse effects on geologic resources such as groundwater and groundwater dependent ecosystems.

Under all Alternatives, those management prescriptions that severely restrict or prohibit ground disturbing activity also protect groundwater located in those management prescription areas, for example, Wilderness, Recommended Wilderness Study Area, National Scenic Areas, Special Biological Areas, and Remote Backcountry Non-Motorized areas. Also, the measures addressing Terrestrial Viability Evaluation under all alternatives also protect groundwater indirectly because groundwater is part of ecosystem or protected habitat in such areas as Alkaline and Mafic Glade and Barrens; Cliff, Talus and Shale Barrens; Floodplains, Wetlands and Riparian; and Cave and Karstlands.

Each Alternative also has a Geologic Area management prescription (4C1) which highlights and provides addition protection for geologic resources. Under the current Plan (Alternative A), the Forest has designated two Geologic Areas (176 acres total): Devils Garden on the Lee Ranger District and Rainbow Rocks on the James River Ranger District. These two Geologic Areas (176 acres total) also would be designated in Alternatives B, C, D, E, F, G, H and I. Alternative E, G, H and I would add more Geologic Special Interest Areas in karst and karst groundwater areas. The Virginia Department of Conservation and Recreation, Natural Heritage Program, identified 19 cave and surrounding conservation areas on the Forest. Two sites are within Special Biological Areas, two are within Indiana bat protection areas, and one is in Wilderness, leaving about 3,700 acres outside of these protected areas. Alternatives E, G, H and I would allocate 14 cave and surrounding

conservation areas (about 3,700 acres total) to Management Prescription 4C1 - Geologic Areas, and thus increase protection of karst groundwater areas.

Karst groundwater areas are widely distributed across the Forest on every District. Potential road construction miles, reflecting ground-disturbing activities associated with management activities will be used as an indicator of potential impact on groundwater. Using this indicator, Alternative C has the lowest potential and Alternative D has the highest potential for impact on groundwater; Alternatives F, B, E, G, H, I, and A have intermediate levels of potential impact.

The potential groundwater withdrawals for Forest use (primarily for developed recreation sites) and/or for authorizations for non-federal groundwater use varies by alternative. Alternative C has the lowest potential and Alternative A has the highest potential for groundwater withdrawals; Alternatives F, D, B, E, G, H and I have intermediate levels of potential for groundwater withdrawals.

CUMULATIVE EFFECTS

Cumulative effects address the environmental consequences from activities implemented or projected within the watersheds in the past, present and reasonably foreseeable future. The combination of activities on NFS, state and private lands can create an effect at a watershed scale that otherwise would not be perceived as a problem at the project or sub-watershed scale. In addition to their natural variability, watersheds differ by their management history, ownership patterns, and the types and levels of contemporary management activity. The combination of natural variables, ownership patterns and management activities contribute to the cumulative effects on water quality within the analysis area. Given the variability in watershed conditions, both natural and management related, the discussion of cumulative effects will be general in nature.

Current water quality in the analysis area is a reflection of the cumulative effects of past and present actions. Future activities can contribute to these effects or alleviate some of the problems. On NFS lands, the reasonably foreseeable future actions are considered to be the continuation of existing programs such as timber management, roads, developed and dispersed recreation, gas and mineral development, grazing allotments, special uses, and other activities. On a broad scale, the effects of future management on NFS lands may result in some localized effects, but overall should not contribute to any measurable downstream impacts. This is due in part to Forest Plan direction for the protection of soil, water, and riparian resources, the continued natural recovery of watershed conditions across the Forest, and the implementation of watershed restoration projects. The level of potential harvest, and its distribution across watersheds, should not result in any measureable water quality effects at the watershed scale. Opportunities also exist to improve watershed conditions.

One concern is that future ground-disturbing activities have the potential to contribute to existing sediment sources, primarily associated with the Forestwide transportation system. Roads continue to be a chronic source of sediment and additional inputs may be detrimental to water quality. The recovery of disturbed soils can be relatively quick, which reduces the erosion potential following the disturbance. But sediment that enters a channel can remain in the system for years, even decades, depending on the level of inputs and channel characteristics. Potential new sources could be off-set, in part or wholly, by correcting existing problems and reducing current inputs.

The influence of NFS land on cumulative effects for waters draining the analysis area largely depends on the level of ownership. NFS lands are typically located in the higher elevations and headwaters, and the influence of state and private lands increases going downstream. In watersheds where NFS lands are limited, the influence of state and private activities is greater.

Water quality is affected by activities on state and private lands, including roads, rural and agricultural developments, logging, mining, and housing developments. State and local Watershed Improvement Plans developed to meet pollution limits for the Chesapeake Bay have the potential to reduce pollutants (nutrients and sediment).

Implementation of Forestwide standards would minimize the potential effects of land management activities on NFS lands and the Forest's potential contribution to cumulative effects. The existing transportation system continues to affect water quality, and foreseeable actions that improve road-related problems can reduce the potential effects and the contribution to cumulative effects. Foreseeable harvest activities have the potential to contribute to sedimentation and cumulative effects associated with conventional logging and road-related impacts. Future harvest activities also provide an opportunity to correct or reduce existing road-related problems and sediment source. Alternative C has the lowest potential for ground-disturbing activities associated with management activities, followed by Alternatives F, A, E, B, G, H, I and D.

One indicator of the potential cumulative effects on groundwater is the amount of past, present, and future management activity in karst, the geologic areas most sensitive to groundwater impacts. The amount of roads is an indicator of the amount of ground-disturbing management activity. The Forest has about 1,800 miles of Forest Service System roads, of which about 281 miles are within the 11% of the Forest with geologic formations containing karst. Alternative C would not construct any system road, and would not add to existing cumulative impacts. Alternatives A, B, D, E, F, G, H and I would add small increments to the existing 1,800 miles of Forest Service System roads, and small increments to the 281 miles within the 11% of the Forest with geologic formations containing karst and karst-related groundwater. Alternatives E, G, H and I would designate 14 cave and surrounding conservation areas (about 3,700 acres total) as Geologic Special Interest Areas, and thus increase protection of karst groundwater areas.

SECTION B - BIOLOGICAL ENVIRONMENT

B1 – ECOLOGICAL SYSTEMS DIVERSITY

AFFECTED ENVIRONMENT

The GWNF is interspersed with tracts of private and other publicly administered lands. National forest lands are significant from an ecological perspective in being relatively large parcels of vegetated and undeveloped lands with focused management goals. National forest lands contain a range of habitats and natural features that support a variety of locally rare species. These aspects plus the continued loss of forested land to developed uses on private lands is likely to make national forest lands even more important in the future for supporting ecological diversity.

Twenty-four ecological systems, as defined by NatureServe's International Ecological Classification Standards, are identified for the analysis of biological resources. However, because many of these ecological systems have similar key attributes, indicators, species associates and resulting forest plan components, we combined the 24 ecological systems into 9 major communities. Additional information on ecological diversity can be found in EIS Appendix E – Ecosystem Diversity Report.

Spruce Forests

This system is dominated by red spruce (*Picea rubens*) and may contain a Balsam fir (*Abies balsamea*) component. Red spruce begins to occur in stands with northern hardwoods (yellow birch, *Betula lutea*; beech, *Fagus grandifolia;* maple spp. *Acer*; etc.) at elevations around 4,500 feet. It becomes more dominant with increasing elevation, and may be the dominant species between 5,000 and 5,500 feet. Common shrub associates of this ecological system include *Rhododendron catawbiense*, *Vaccinium erythrocarpum* and *V. constablaei, Rubus canadensis,* and *Viburnum alnifolium.* The herb layer commonly includes *Oxalis montana, Dryopteris campyloptera, Aster divaricatus, Clintonia borealis, Solidago glomerata, Carex pennsylvanica* and *Maianthemum canadense,* as well as a variety of other species. This community is characterized by relatively high moisture levels, short growing seasons, acidic soils with low levels of nutrients, and are often subject to strong winds and other extreme weather conditions.

Spruce-fir forests are low disturbance systems, with most of the area under forest canopy. Adverse effects caused by air pollution have caused significant mortality of overstory trees in many areas throughout its range, making quality examples of this community very rare and threatening the persistence of many associated species. The George Washington National Forest has not experienced significant mortality to date.

The forests provide key habitat for the Virginia northern flying squirrel, *Glaucomys sabrinus fuscus.* Isolated populations of several birds--the northern saw-whet owl *(Aegolius acadicus),* the black-capped chickadee *(Parus atricapillus)*, the red crossbill *(Loxia curvirostra)* and the olive-sided flycatcher (*Contopus borealis*)--occur at these high elevations and are uncommon or rare elsewhere in the southeast.

Within the Southern Appalachians, the southern extent of this habitat association coincides approximately with the state lines where Tennessee, North Carolina and Georgia come together. The northern extent of the association is roughly coincident with the northern boundary of the Monongahela National Forest. These forests are confined to the highest peaks of Virginia, Tennessee, and North Carolina. They provide a cool, moist habitat similar to the boreal forests found at more northern latitudes.

There are about 85,000 acres of spruce-fir forest in the region (SAMAB 1996:168-169). Of this total, 11,700 acres are on national forests. These stands occur on the George Washington, Jefferson, and Cherokee National Forests, and the National Forests in North Carolina. Of the remainder, 62,700 acres are in other public ownership (mostly National Park Service), and 10,600 acres are in private or corporate ownership. Most of the public land (including 39% of the NFS land) is in late successional stage (81 yrs. +) forests. At the time of the Southern Appalachian Assessment (1996), four percent of the National Forest acres were in the sapling/pole

(11-40 yrs.) stage and 57% were in the mid-successional (41-80 yrs.) stage. All of the private holdings are in either the sapling/pole stage or the mid-successional stage.

There are approximately 500 acres of spruce forest on the GWNF located in the Laurel Fork area of Highland County, VA. This area is currently identified as a Special Management Area to be managed to maintain or enhance the special biological features of the area, including the Central and Southern Appalachian Spruce-Fir Forest.

Northern Hardwood Forests

Hemlock and Northern Hardwood forests are broadly defined to include those forested communities that are either dominated or co-dominated by eastern hemlock (*Tsuga canadensis*) or sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and associates. For the purposes of this analysis, forests with a significant component of eastern hemlock are classified as hemlock forests, even where white pine may be dominant. This division puts priority on the presence of hemlock as a key habitat component. Northern Hardwood forests generally occur as the Sugar maple-beech-yellow birch forest type on the GWNF.

Eastern hemlock forests typically occur on acidic soils and often have a dense shrub layer composed of ericaceous species. These communities are typically low in herbaceous diversity, but may support rich bryophyte communities. The combination of a largely evergreen canopy and a dense midstory in naturally occurring hemlock provide for a variety of benefits, including shading and cooling of riparian systems, thermal cover for wildlife, and nesting and foraging habitat for several species of neotropical migrant birds dependent upon the layered canopy structure and understory thickets (Rhea and Watson 1994). There is some evidence that forests provide necessary habitat components for the long-term conservation of red crossbills (Dickson 2001). Eastern hemlock forests may also be important refugia for species typically adapted to higher elevations. Dickson (2001) states that red-breasted nuthatches, winter wrens, and golden-crowned kinglets are found in late successional hemlock forests down to elevations of 2,000 feet, and several species of rare bryophytes that are known to occur primarily within the spruce/fir zone are also found at lower elevations in humid gorges often under a canopy that includes eastern hemlock (Hicks 1992). Unfortunately, a vast majority of these forests have been severely impacted by the hemlock woolly adelgid resulting in severe or total mortality of hemlock. While it is not known what percentage of these older aged stands has succumbed to this non-native pest, we can assume that little or no hemlock forest remains unaffected or wholly intact.

A number of bird species, including the cerulean warbler (*Dendroica cerulea*) favor mature, northern hardwood forests with a diverse and well-developed canopy structure including canopy gaps and associated midstory and understory structural diversity (Hunter, et al. 2001; Rodewald and Smith, 1998). This structural diversity may be characteristic of the decadent, patchy conditions found in old growth forests, to which these species have presumably adapted. While a growing portion of the landscape in the Southern Appalachians consists of large hardwoods, most sites have very simple canopy structures (Runkle, 1985). This lack of structure is likely the result of previous even-aged timber management, resulting in forest stands of approximately equally-aged trees with low mortality and few canopy gaps. Most of these mid- and late successional forests have not yet begun to develop the canopy gaps characteristic of old growth forests. It may be many centuries before such structure develops through natural succession. For the Southern Appalachian Assessment area, the majority of the northern hardwood forests are currently in older age classes. Across all ownerships, approximately 75-80% of maple-beech-birch (northern hardwoods) is in mid- and late-successional stages. On the GWNF approximately 11,000 acres, or 1% of the forest, is found in northern hardwood forests. Approximately 98% of this forest type is in mid- and late-successional forest.

Cove Forests

This system is dominated by yellow poplar (*Liriodendron tulipifera*) and may contain white pine (*Pinus strobus*), various species of ash (*Fraxinus spp.*), and basswood (*Tilia Americana*) as associates. This community is characterized by relatively low levels of disturbance, and from a habitat perspective, their primary value is providing habitat for a variety of species dependent on mid- and late successional forest stages. It should be noted that the more mesic oak forest types are not addressed in this section, but are analyzed in the Oak and Oak Pine section.

The cove forests addressed in this section are relatively uncommon in the Southern Appalachian Assessment area, comprising just over 10% of the land area (SAMAB 1996:23). Cove forest communities such as mixed mesophytic and bottomland hardwood forests comprise 8.4%, and 1.2%, respectively, of the land area of the SAA area. While these forest communities occur throughout the entire forest, approximately 6% of the GWNF is comprised of cove forests.

A number of bird species, including the cerulean warbler (*Dendroica cerulea*) favor mature, cove forests with a diverse and well-developed canopy structure including canopy gaps and associated midstory and understory structural diversity (Ramey 1996; Buehler and Nicholson 1998; Rodewald and Smith1998; Nutt 1998). This structural diversity may be characteristic of the decadent, patchy conditions found in old growth forests, to which these species have presumably adapted. While a growing portion of the landscape in the Southern Appalachians consists of large hardwoods, most sites have very simple canopy structures (Runkle 1985). This lack of structure is likely the result of previous even-aged timber management, resulting in forest stands of approximately equally-aged trees with low mortality and few canopy gaps. Most of these mid- and late successional forests have not yet begun to develop the canopy gaps characteristic of old growth forests. It may be many centuries before such structure develops through natural succession.

Oak Forests and Woodlands

The major species include chestnut oak (*Quercus montana*), northern red oak (*Q. rubra*), black oak (*Q. velutina*), white oak (*Q. alba*), and scarlet oak (*Q. coccinea*) (USDA Forest Service, 1997). The drier sites contain oak-pine forests which are oak-dominated forests containing a significant pine component. Predominant pine species include white pine (*Pinus strobus*), shortleaf pine (*P. echinata*), and Virginia pine (*P. virginiana)*

Complexes of woodlands, savannas, and grasslands were once a frequent occurrence across the southeastern landscape, maintained with frequent fire on xeric ridge-tops and south-facing slopes (DeSelm and Murdock 1993; Davis et al. 2002). Woodlands are open stands of trees, generally forming 25 to 60 percent canopy closure (Grossman et al. 1998:21) and may be of pine, hardwood (typically oak), or mixed composition. Savannas are usually defined as having lower tree densities than woodlands; grasslands are mostly devoid of trees. All of these conditions typically occurred in mixed mosaics within a fire maintained landscape. In all cases, a well-developed grassy or herbaceous understory is present.

Because existing woodland, savanna, and grassland complexes are rare, do not conform to existing definitions of community types, and are not consistently tracked, the current acreage in such condition is not well documented. This vegetative condition is not a community type in and of itself, but rather, could occupy some sites allocated to other formally defined community types. The woodlands, savannas, and grasslands are expected to occupy the most xeric sites of the dry and xeric oak forest, woodland, and savanna and the xeric pine and pine-oak forest and woodland community types. These community types are most likely to occupy sites that historically supported woodlands, savannas, and grasslands.

Existing remnants of this habitat and several associated rare species in both the Southern Appalachians and Piedmont are limited primarily to roadsides and powerline rights-of-way (Davis et al. 2002) due to reductions in fire frequency across most landscapes.

The abundance of these forests in the future will be primarily dependent on the management of existing oak stands to maintain oak dominance. However there also are opportunities to increase the availability of these forests, especially the mixed oak-pine types, through various regeneration techniques and supplemental planting of pine species.

Across the Southern United States, about 50% of the upland hardwood forests (predominantly oak-hickory) and 30% of the natural oak-pine forests are in mid- and late successional stages (41+ years of age) (USDA Forest Service 2001). However, only about 1% of the planted oak-pine forests are in mid- and late successional stages. For the Southern Appalachian Assessment Area, approximately 75% of oak-hickory forests are in mid- and late successional stages (SAMAB 1996: 165).

The age class distribution on the GWNF follows a pattern common to many other Southern Appalachian Forests. However, on the GWNF, this pattern is a little more extreme with over 90% of these community types in a mid-late successional stage.

The structural condition of these oak forests and woodlands is a key factor in the maintenance of these communities. Research indicates that these forest communities may not perpetuate themselves without some level of disturbance, especially on mesic sites (Loftis 1991). Treatments such as shelterwood harvest combined with prescribed burning (Brose et al. 1999) or basal area reduction from below using herbicides (Loftis 1990) have been shown to create conditions that promote adequate oak regeneration. Once established and grown to an average height of approximately 4.5 feet, oak advanced regeneration should be released and provided relatively full sunlight to encourage quick growth into the canopy of the regenerated stand. Oak dominance can be maintained with suitable tree densities and moderate fire return intervals.

Mid- and late successional oak forests and woodlands provide an important source of hard mast and dens. Acorns are a critical fall and winter food for numerous wildlife species (Martin et al. 1951). The availability of acorns has been shown to strongly influence population dynamics of species such as black bear (Pelton 1989), squirrels (Nixon et al. 1975), white-tailed deer (Wentworth et al. 1992) and white-footed mice (Wolff 1996). The large diameter hollow trees and snags found in older oak forests also are an important source of dens for black bears (Carlock et al. 1983). Hard mast production is an important habitat feature for a several wildlife species in demand for sport hunting. These include white-tailed deer, wild turkey, squirrels, and bear.

Pine Forests and Woodlands

These systems are often referred to as southern yellow pine forests and occur on a variety of landforms at a wide range of elevations. Historically, in the Blue Ridge Physiographic Province, these communities occupied areas that were subject to natural fire regimes and typically occurred on ridges and slopes with southern exposures (NatureServe 2002). However, due to a combination of previous land use, fire exclusion, and intensive forestry (plantations), many pine species that do not tolerate fire well have expanded beyond their normal sites and today, pine-dominated communities can be found on a variety of landforms and aspects. Meanwhile, pine species, such as table mountain pine, that benefit from, or depend upon fire, have been reduced in abundance.

Complexes of woodlands, savannas, and grasslands were once a frequent occurrence across the southeastern landscape, maintained with frequent fire on xeric ridge-tops and south-facing slopes (DeSelm and Murdock 1993; Davis et al. 2002). Woodlands are open stands of trees, generally forming 25 to 60 percent canopy closure (Grossman et al. 1998:21) and may be of pine, hardwood (typically oak), or mixed composition. Savannas are usually defined as having lower tree densities than woodlands; grasslands are mostly devoid of trees. All of these conditions typically occurred in mixed mosaics within a fire maintained landscape. In all cases, a well-developed grassy or herbaceous understory is present.

Because existing woodland, savanna, and grassland complexes are rare, do not conform to existing definitions of community types, and are not consistently tracked, the current acreage in such condition is not well documented. This vegetative condition is not a community type in and of itself, but rather, could occupy some sites allocated to other formally defined community types. This vegetative type forms a subset of the oak, oak-pine, and pine-oak forests analyzed in depth elsewhere in this document. The woodlands, savannas, and grasslands are expected to occupy the most xeric sites of the dry and xeric oak forest, woodland, and savanna and the xeric pine and pine-oak forest and woodland community types. These community types are most likely to occupy sites that historically supported woodlands, savannas, and grasslands.

Existing remnants of this habitat and several associated rare species in both the Southern Appalachians and Piedmont are limited primarily to roadsides and powerline rights-of-way (Davis et al. 2002) due to reductions in fire frequency across most landscapes.

During the last 50 years across the southeastern United States, pine plantations have increased in importance in terms of a supply of wood products, expanding from 1% of the total pine forest acres to 48% of those acres (USDA Forest Service 2001: 1). It should be noted, however, that this expansion has occurred primarily in the

piedmont and coastal plains of the south; relatively few pine plantations have been established on the GWNF or in the mountains of Virginia. At the same time, the 20-year trend reported for the Southern Appalachian Assessment area (SAMAB 1996: 27) shows a downward trend of 16% for southern yellow pine forests. This trend is not, however, reflected in monitoring of this community type on the George Washington and Jefferson National Forests (GWJNF). The number of acres in this community type inventoried through FSVeg on the GWJNF has decreased less than 1% over the past decade (George Washington and Jefferson National Forest 2001). However, Forest Inventory and Analysis data indicate a substantial decrease in the acres of Virginia, pitch, and table mountain pines on the GWJNF since 1977 (George Washington and Jefferson National Forest 2001). So, while the decrease in the yellow pine community may not have been significant over the past decade, it has been dramatic over the past 30 years, indicating that much of the loss occurred prior to the past decade. A shift from more fire tolerant yellow pines to less fire tolerant pines may also be masked in this data. The GWNF currently contains approximately 160,000 acres in the xeric pine forest and woodland community type, representing about 15% of the GWNF.

Portions of the GWNF experienced a southern pine beetle epidemic in the mid 1990s. While the exact acreages of southern yellow pine forests that were severely impacted are not known, this insect pest certainly resulted in a recent significant impact in terms of the condition or quality of existing yellow pine stands. Many of the sites impacted were densely stocked stands of Virginia, table mountain, and/or pitch pine that had proliferated beyond their normal sites due to fire suppression and land management practices of the past 70 years. Historical data suggests that large areas that have become occupied by even-aged stands of yellow pine would have naturally supported mixed stands with varying levels of hardwoods. Some areas experiencing frequent fire would have contained open understories with grassy and/or herbaceous ground cover. These natural communities are maintained by low intensity fires originating on ridgetops and southern exposures (NatureServe 2002). Other areas with less frequent fire would contain a mix of pine and hardwood species. With large-scale mortality in these communities due to pine beetle effects, the opportunity now exists to restore the condition and/or quality of these sites to a more open pine woodlands or natural mixed pine hardwood community. On the GWNF, the pine forest and woodland community is well distributed throughout the ridge and valley province. However, this type is currently less abundant on the richer Blue Ridge Province soils of the Pedlar District.

The Southern Appalachian Assessment (SAMAB 1996) summarizes the age class distribution of southern yellow pine forests across the Southern Appalachian Assessment Area by a variety of land ownerships. Similar information is derived from queries of the GWNF FSVeg Database. This data indicates that this community type is very strongly skewed to the older age classes as compared to the Southern Appalachian Assessment area as a whole.

While public lands support the majority of late successional acres, the structure and composition of these forests has been altered due to years of fire suppression resulting in less than optimal habitat conditions. Fire intolerant species such as Virginia pine have proliferated while other pines (shortleaf, pitch, table mountain) have seen dramatic reductions (Nature Serve 2002, Martin et al. 1993). In the absence of fire, hardwoods, shrubs, and vines have replaced the open, grassy, herbaceous layer that is characteristic of frequently burned areas, and hardwoods have encroached into the midstory further affecting forest structure. This change in forest structure and resulting habitat condition has had a direct effect on species dependent upon these communities. Populations of several bird and reptile species associated with southern pine forests are in decline (Dickson 2001) as various habitat components are lost. In addition to declines in species dependent upon specific habitat attributes, entire pine communities are experiencing a reduction in abundance. Recent studies show that acreage of table mountain pine communities (considered a rare community in the southern Appalachians) has decreased due to fire suppression (Turrill and Buckner 1995) and that many remaining examples have substantial hardwood invasion. However, recent monitoring of the table mountain pine types on the GWJNF indicates the decline of table mountain pine has stabilized since 1977 (George Washington and Jefferson National Forest 2001).

Alkaline and Mafic Glades and Barrens

These systems are characterized by thin soils and exposed parent material that result in localized complexes of bare soils and rock, herbaceous and/or shrubby vegetation, and thin, often stunted woods. During wet periods

they may include scattered shallow pools or areas of seepage. Glades, barrens, and associated woodlands differ from rock outcrop communities by exhibiting soils and vegetative cover over the majority of the site, and differ from the more widespread woodland communities in that they occur on geologic substrates which are unique for the region, including limestone, dolomite, amphibolite, greenstone, mafic rock, serpentine, sandstone, or shale. Associated communities include Calcareous Woodlands and Glades, Mafic Woodlands and Glades, Serpentine Woodlands and Glades, and Shale Barrens as defined in the Southern Appalachian Assessment (SAMAB 1996). At minimum, this rare community complex includes rare associations within the following ecological groups as defined by NatureServe (2001a): 401-17 Appalachian Highlands Calcareous/Circumneutral Dry-Mesic Hardwood Forest.

Cliff, Talus and Shale Barrens

These systems are a variable group of sparse woodlands, shrublands, and open herbaceous rock outcrops occurring on Ridge and Valley shales and Blue Ridge metashales of the Central Appalachian Mountains. These small-patch communities range from western Virginia and eastern West Virginia to southern Pennsylvania. In Virginia, they occur at elevations from 850 to 3,040 feet. Although stunted trees of several species (*e.g.*, *Quercus pinus*, *Pinus virginiana*, and *Caria glare*) are common, shale barrens are strongly characterized by their open physiognomy and by a suite of uncommon to rare plants found almost exclusively in these habitats. Endemic or near-endemic shale barren species include *Arabic serotonin*, *Clematis alb coma*, *Clematis viticaulis* (also endemic to Virginia), *Eriogonum allenii*, *Oenothera argillicola*, *Packera antennariifolia* (= *Senecio antennariifolius*) and *Trifolium virginicum*. Habitats generally occur on steep (~ 30 degree) slopes with south to west aspects. The steep, xeric slopes and friable nature of the shale create poorly vegetated hillsides of bare bedrock and loose channery visible from afar. Continual undercutting of thick but relatively weak shale strata by streams maintain shale barrens. Less common, densely graminoid-dominated variants occurring on steep spur ridge crests and mountain summits are sometimes referred to as “shale ridge balds.” Shale barrens are considered globally uncommon and host many locally rare species including the butterflies Appalachian grizzled skipper (*Pyrgus wyandot*) and Olympia marble (*Euchloe olympia*) and the federally listed plant *Arabis serotina*. The primary threat to these communities is probably invasion by non-native invasive species, but examples of these communities near roads are also threatened by quarrying.

Floodplains, Wetlands and Riparian Areas

This system includes floodplains, streams, riparian areas, wetlands, bogs, fens, seeps, lakes, and ponds that may be found in both the Appalachian and Piedmont regions, and are characterized by: 1) soils that may be semi-permanently to permanently saturated as a result of groundwater seepage, perched water tables, rainfall, or beaver activity, and alluvial processes; and 2) presence of wetland-associated species such as sphagnum, ferns, and sedges. Dominant vegetation may be herbs, shrubs, trees, or some complex of the three. Ponds in this group include limesink, karst, and depression ponds, which may hold areas of shallow open water for significant portions of the year. Also included are all impoundments and associated wetlands resulting from beaver activity. Artificial impoundments are not included, unless they support significant populations or associations of species at risk. The primary management need is that of protection from activities that could disrupt wetland hydrology or other community structures and functions. Some sites may require periodic vegetation management to maintain desired herbaceous and/or shrubby composition. Rare mountain wetland communities include Mafic and Calcareous Fens, Sphagnum and Shrub Bogs, Swamp Forest-Bog Complex, Mountain Ponds, Seasonally Dry Sinkhole Ponds, and Beaver Pond and Wetland Complex as defined in the Southern Appalachian Assessment (SAMAB 1996).

Cave and Karstlands

This system includes the terrestrial and aquatic subterranean habitat. The landscapes are formed in limestone and dolostone bedrock and are generally found in valley bottoms but occasionally on ridges and mountains depending on bedrock geology, strata location and outcrops. Passages are formed by water flowing over many millennia. It is not a separate ecological system from the others, since it has vegetation defined by the previously discussed systems. It is the underground environment and the features that sometimes manifest themselves at the surface, like sinkholes, caves and springs. The location is defined by broad scale geologic mapping, so the actual areas of caves and karst terrain occupy only a small portion of the entire area.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Effects of the alternatives on the ecological systems of the GWNF are based on modeling of the extent of the ecological systems across the Forest. Objectives of timber harvest and prescribed burning were modeled through the next 50 years for each alternative. The current conditions of the systems are then compared to the modeled results. These results are compared to the biophysical settings identified through LANDFIRE for the systems on the GWNF.

LANDFIRE (also known as Landscape Fire and Resource Management Planning Tools) is interagency vegetation, fire, and fuel characteristics mapping program, sponsored by the United States Department of the Interior (DOI) and the United States Department of Agriculture, Forest Service. The Biophysical Settings (BpS) layer represents the vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. It attempts to incorporate current scientific knowledge regarding the functioning of ecological processes – such as fire – in the centuries preceding non-indigenous human influence. Map units are based on NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units (Comer and others 2003). LANDFIRE's use of these classification units to describe biophysical settings differs from their intended use as units of existing vegetation. As used in LANDFIRE, map unit names represent the natural plant communities that may have been present during the reference period. Each BpS map unit is matched with a model of vegetation succession, and both serve as key inputs to the LANDSUM landscape succession model (Keane and others 2002). The LANDFIRE BpS concept is similar to the concept of potential natural vegetation groups used in mapping and modeling efforts related to fire regime condition class (Schmidt and others 2002; www.frcc.gov).

Structure and Tree Age Diversity

Structure and tree age diversity are both characteristics that are important to all forested ecological systems. Structure is also important to non-forested systems. Every forested community requires a balance of age-class conditions representing a diversity of vertical structure that allows for recruitment of young growth to replace losses due to storm events, pest infestations, wildfires, and loss of over-mature trees. An appropriate balance of vertical structure within each community provides critical habitat for associated species that require either grass/forb-seedling/shrub (early seral), and/or trees (late seral).

Canopy structure reflects the general health and sustainability of the community by the amounts and arrangement of early seral and mature stands. Canopy closure, as a surrogate for horizontal structure, was measured as a combination of stem density, basal area and extent of canopy cover. This measure was used primarily to delineate forested (closed canopy) from open canopy and woodland conditions.

Definitions of Structural Classes

Open	Land with less than 10 percent canopy cover in permanent or long-term open condition (grasslands, barrens, etc.; not newly cut forest regeneration.)
Early Successional or Regenerating Forest	Stands developing after a major disturbance, generally less than 11 years in age in the most common systems, but can be up to 35 years.
Mid-Successional Open Canopy	Stands beyond regeneration that stay in a relatively open canopy (canopy closure of 25-60%)
Mid-Successional Closed Canopy	Stands beyond regeneration where the canopy closes (canopy closure of 61% or greater)
Late Successional Open Canopy Forest	Stands reaching older ages of mature trees (50-100 years or greater) and more lasting structural conditions with overall open canopy (canopy closure of 25-60 percent; typical of thinned forests)
Late Successional Closed Canopy Forest	Stands reaching older ages of mature trees (50-100 years or greater) and more lasting structural conditions with a largely closed canopy (all layers) greater than 60 percent. Includes natural canopy gaps.

Successional Forests, Early Successional Habitat, Openings, Open Woodlands

Successional stages of forests are the determining factor for presence, distribution, and abundance of a wide variety of wildlife. Some species depend on early successional forests, some depend on late successional forests, and others depend on a mix of both occurring within the landscape (Franklin 1988; Harris 1984; Hunter et al. 2001; Hunter 1988; Litvaitis 2001). These habitat conditions are also important as wintering and stopover habitats for migrating species (Kilgo 1999; Suthers 2000; Hunter et al. 2001). Therefore, it is important that varying amounts of both types of habitat be provided within national forest landscapes.

For analysis purposes, forest succession is generally divided into three stages: early, mid, and late. Early successional forest is defined as regenerating forest of 0 to 35 years of age for depending upon the ecological system. It is characterized by dominance of woody growth of regenerating trees and shrubs, often with a significant grass/forb component, and relatively low density or absent overstory. This condition is distinguished from most permanent opening habitats by dominance of relatively dense woody vegetation, as opposed to dominance of grasses and forbs. Such conditions may be created by even-aged and two-aged regeneration cutting, and by natural disturbance events, such as windstorms, severe wildfire, and some insect or disease outbreaks. Ages defining the remaining successional stages vary by ecological system. Mid-successional forest often begins to develop with the sapling/pole forest characterized by canopy closure of dense tree regeneration, with tree diameters typically smaller than 10 inches. It then proceeds through stratification of over-, mid-, and understory layers. Late successional forests, from 50 to 100 years in age and older, include old growth conditions. This stage contains the largest trees and often has well-developed canopy layers and scattered openings caused by tree mortality. Of particular importance as habitat are forest conditions that exist at both extremes of the forest successional continuum-early successional and late successional forests.

Another important type of forest that combines elements of both early and mid – to late successional forest is open woodlands. Created and maintained largely by periodic fire disturbance regimes, open woodlands are characterized by an overstory of trees that are spaced far enough apart to allow sunlight to reach the forest floor. This structural condition allows the development of a grassy/shrubby/herbaceous/woody understory more typical of early successional forest and grassland/shrublands. Many high priority species depend on the juxtaposition of both overstory mature and a well-developed grassy/shrubby/herbaceous understory for their life cycle needs. Northern bobwhite quail, red-headed woodpecker, brown-headed nuthatch, northern flicker, Appalachian yellow-bellied sapsucker, eastern wood-pewee, golden-winged warbler, Indiana bat, pine snake, grizzled skipper, box huckleberry, shale-barren rock cress, small-spreading pogonia, sword-leaf phlox, variable sedge, and smooth coneflower are just a few high priority species dependent upon open woodland habitat.

Early successional forests are important because they are highly productive in terms of forage, diversity of food sources, insect production, nesting and escape cover, and soft mast. Early successional forests have the shortest lifespan (usually about 10 years) of any of the forest successional stages, and are typically in short supply and declining on national forests in the Southern Appalachians (SAMAB 1996:28), and in the eastern United States (Thompson 2001). Early successional forests are also not distributed regularly or randomly across the landscape (Lorimer 2001). These habitats are essential for some birds (ruffed grouse, chestnut-sided warbler, golden-winged warbler, prairie warbler, yellow-breasted chat, blue-winged warbler, Swainson's warbler); key to deer, turkey, and bear in the South; and sought by hunters, berry pickers, crafters, and herb gatherers for the wealth of opportunities they provide (Gobster 2001). Many species commonly associated with late successional forest conditions also use early successional forests periodically, or depend upon it during some portion of their life cycle (Hunter et al. 2001).

The need for seedling/sapling conditions to provide habitat for birds associated with early successional habitats is a current topic of concern. Old fields can provide conditions required by many early seral species, but this habitat type itself is very uncommon on the National Forest. The minimal area that is required by each species varies and is not fully understood. Kirpez and Stauffer (1994) documented local research findings that harvest groups of approximately 0.5 to 2 acres in size provide suitable habitat for such early seral dependent birds as the indigo bunting and rufous-sided towhee. In addition, local U.S. Forest Service bird monitoring efforts have identified the chestnut-sided warbler, an early seral species, inhabiting group harvest areas of less than 1 acre in size. In a discussion of management of early-successional habitats, Thompson and Dessecker (1997) identified group selection areas of less than 0.5 acres as inadequate for a variety of forest songbirds.

Thus, there is a group of forest songbirds, such as the prairie and golden-winged warblers, which require disturbance patches that are less than 10 years of age and greater than 2 acres is size. Thus, the early successional forest habitat that will be created in patches greater than 2 acres will result from even-aged timber harvest.

In addition to structure and patch size, the elevation at which early seral habitats exist plays a role in providing habitat for some species. The chestnut-sided warbler typically occurs at higher elevations on the GWNF. Thus, provision of seedling/sapling habitat needs to be considered at both high and lower elevations.

Eastern hardwood stands begin to produce significant amounts of hard mast at about age 40. Hard mast is a very important component for many wildlife species such as bear, squirrel, and turkey. Therefore, the age at which hardwood stands begin to produce adequate amounts of hard mast, especially upland hardwood stands dominated by oak species, is an important stage in stand development. Hard mast production is highly variable between species as well as individuals of the same species. Hard mast production in any given year is dependent upon many factors including climate and weather, insects and disease, stand density, size of trees, stand composition, and stand age. Many of these factors are either beyond control (e.g. weather) or more appropriately considered at site specific levels (e.g. stand density). For the purposes of effects analysis and disclosure at the Forest Plan level, stand age and stand composition are excellent indicators of a stand's hard mast production capability.

The five major oak species (*Quercus alba, Q. prinus, Q. velutina, Q. rubra,* and *Q. coccinea*) all begin hard mast production at ages from 20 to 25 years old. Maximum acorn production is achieved at 40 to 50 years old. *Carya glabra*, *C. tomentosa*, and *Fagus grandifolia* produce hard mast in quantity at ages of 30 to 40 years. Finally, *Tilia americana* can begin producing adequate amounts of hard mast as early as 15 years old. (Burns and Honkala 1990.) Goodrum and others found that acorn yields tended to be largest in the classes from 40 to 49 years old up to 90 to 99 years old, but declined thereafter (Goodrum et al. 1971). Shaw arrived at a similar conclusion when he found that stands in his study area ranging from 40 to 80 years old comprised 50% of the management unit, but produced 90 percent of the acorn crop. (Shaw 1971.) Thus, the age of 40 years old as the beginning of significant hard mast production in eastern hardwood forests is widely accepted.

Like early successional forests, late successional forests provide habitats and food supplies for a suite of habitat specialists as well as habitat generalists. These habitats are important providers of high canopy nesting, roosting, and foraging habitat, suitable tree diameters for cavity development and excavation, and relatively large volumes of seed and hard mast. Although it takes many decades for late successional forest conditions to develop, these habitats are more common and contiguous across the national forest and are dominant features in the SAA area (SAMAB 1996:28).

At the time of the SAA, National Forest System lands had only 3% of forest habitats in the early successional stage, while 89% was in the mid- and late successional classes; 45% of this was late successional forest (SAMAB 1996:168). Other public lands were similar to the National Forest. Conversely, private industrial lands had 22% in early successional forest and only 4% in late successional forest; private non-industrial had 8% in early successional forest and 9% in late successional forest (SAMAB 1996:168-169). The 20-year trends (SAMAB 1996:28) show early successional forest on National Forests decreasing by 4%, with late successional forest increasing by 34%. Trends for private forests are mixed, with increases in both early- and late successional forest percentages. These results likely reflect the mixed objectives of private landowners, with some focusing on commodity production and others on amenity values. In general, on National Forest System lands forest conditions are weighted heavily toward total acres of older forests, while private forests are providing a more balanced distribution of forest successional conditions from young to old (Trani-Griep 1999).

Quality of forest successional habitats may also vary between private and national forest system lands. Objectives on national forests to provide for wildlife habitat needs, recreational activities, scenic integrity objectives, and water quality often result in greater vegetation structure retained in early successional forests than in similar habitats on private lands. On private lands, more intensive management may simplify structure and composition, reducing habitat quality. Similarly, effort to restore and maintain desired ecological conditions and processes in mid- and late successional forests also often enhances habitat quality over that

found on private lands. For these reasons, conclusions regarding cumulative habitat availability from both private and national forest system lands must be made with caution.

Hurricanes (Foster 1992), lightning frequency (Delcourt 1998), fire frequency (Whitney 1986), and pre-settlement cultural activities (Delcourt 1987) were probably the major sources of disturbance events that created early successional forests prior to European occupation. Less drastic perturbations such as mortality events from tornadoes, insect or disease outbreaks, or defoliation (passenger pigeon roosts) were typically less extensive and cyclic but nonetheless provided a source of early successional forest conditions. Natural disturbances, however, are unpredictable, episodic, and heterogeneous (Lorimer 2001); influential at a landscape scale; and are neither uniform nor random in distribution. Anthropogenic disturbances occurred more frequently in floodplains along major rivers and in "hunting grounds." In a recent review paper by disturbance ecologist Craig Lorimer (Historical and ecological roles of disturbance in eastern North American forests: 9,000 years of change. Wildlife Society Bulletin 2001, 29(2):425-439), Lorimer states that predicting frequency of more severe natural disturbances (the kind that would create desired early-successional forest patches) is difficult because they are highly episodic and spatially heterogeneous. Lorimer goes on to state: "…the episodic nature of large natural disturbances creates a sort of 'feast or famine' environment that may subject early successional animal populations to erratic fluctuations…" Such feasts and famines may be especially extreme when looking at the smaller natural landscapes represented by national forests, surrounded by private lands that may be converted to nonforest. Successional forest objectives are designed to reduce the feast and famine swings for early-successional forest species, while providing ample habitat for mature forest species.

Overall, landscape patterns more consistently contain a component of early successional forests in places more "likely" to be susceptible to disturbances, i.e., south and west facing slopes, sandy or well drained soils, or in fire adapted plant communities. Fire suppression, intensive agriculture resulting in massive soil losses, land use changes, and urban sprawl have drastically altered the variables that would perpetuate a landscape with a significant component of early- successional forests. With many species associated with early successional forests in the southeast in decline (Hunter et al. 2001), it is imperative that management actions include some provision for perpetuating early successional forest conditions. At the same time, many of these same factors, especially land use conversion, have reduced the distribution and abundance of quality late successional forests across the larger landscape. Maintenance of these on public lands is equally imperative.

Permanent grass/forb and seedling/sapling/shrub habitats are important elements of early successional habitat. Permanent openings typically are maintained for wildlife habitat on an annual or semi-annual basis with the use of cultivation, mowing, or other vegetation management treatments. These openings may contain native grasses and forbs or may be planted to non-native agricultural species such as clover, orchard grass, wheat, or small grains. Old fields are sites that are no longer maintained, are maintained on a less frequent basis (5-10 year intervals, usually with burning and mowing) or are succeeding to forest. They are largely influenced by past cultural activities and may be dense sod or a rapidly changing field of annual and perennial herbs, grasses, woody shrubs and tree seedlings.

Permanent openings are used by a variety of wildlife, both game and non-game species. Parker and others (1992) reported use of agricultural openings by 54 species of birds and 14 species of mammals in a study on the Chattahoochee National Forest. Bird species observed included wild turkey, several species of raptors and woodpeckers, and numerous songbirds including a number of neotropical migrants such as pine warbler, ovenbird, and black-throated green warbler. The greatest number of avian species and highest bird species diversity was found within the edge zone of the openings. Mammals observed included species such as white-tailed deer, striped skunk, woodchuck, bobcat, black bear, red bat, eastern cottontail, opossum, and several other small mammals.

The benefits of permanent openings to white-tailed deer are well documented. Permanent openings, especially those containing grass-clover mixtures, are used most intensively in early spring, but also are an important source of nutritious forage in winter, especially when acorns are in short supply (Wentworth et al. 1990; Kammermeyer et al. 1993). Kammermeyer and Moser (1990) found a significant relationship between openings and deer harvest with only 0.13% of the land area in high quality openings. Forest openings also are a key habitat component for wild turkeys throughout the year (Thackston et al. 1991; Brenneman et al. 1991).

Maintained openings provide nutritious green forage in the winter and early spring and seeds during late summer and fall. Because of the abundance of insects and herbaceous plants produced in these openings, they are especially important as brood rearing habitat for young turkeys (Nenno and Lindzey 1979, Healy and Nenno 1983). Linear openings, especially those associated with young regenerating forests, provide optimal brood habitat conditions for ruffed grouse (Dimmick et al. 1996).

There also are numerous wildlife benefits from openings maintained in native species. Native warm season grasses provide nesting, brood-rearing, and roosting habitat for northern bobwhite and other grassland species of wildlife (Dimmick et al. 2001). Native species are well adapted to local environments and generally require less intensive maintenance following establishment.

Old fields provide food and cover for a variety of wildlife species. A number of disturbance-dependent birds, such as northern bobwhite, grasshopper sparrow, golden-winged warbler, and blue winged warbler, are associated with old field habitat (Hunter et al. 2001). Recently abandoned fields are important for rabbits and many small mammals (Livaitis 2001). Woodcock use old fields as courtship, feeding, and roosting sites (Straw et al. 1994; Krementz and Jackson 1999). Although managed less intensively than other types of permanent openings, some degree of periodic management is necessary to maintain these habitats.

Species Composition

While changes in the extent of the ecological systems are not modeled, there are some changes in the species composition of the oak systems that could be expected over time. These changes would be most common in areas where timber harvest and prescribed burning are not used. They would therefore be more likely to be seen in Alternative C than in the other alternatives.

The variety of overstory and understory plants presently existing in stands of chestnut oak and scarlet oak could decline over time as forest succession follows its expected course. Chestnut oak could become more dominate as the single major overstory species. Several yellow pine species could decline significantly, except on the most severely dry and rocky sites already occupied only by table mountain pine. Bear oak barrens could disappear as tree species invade them and less frequent fires no longer initiate the regeneration process. On these dry sites, shrubs dominate the understory and the herbaceous layer is sparse. The understory vegetation which is dominated by plants of the heath family could change dramatically as disturbances (mainly fire) become less frequent. If a more closed canopy develops from the dominance of chestnut oak in the overstory and fires are less frequent, herbaceous plants may become more prevalent and shrubs less abundant Oaks could be replaced by red maple, black gum, black locust, sassafras and some yellow pines as a result of gypsy moth and oak decline impacts.

The variety of overstory trees presently existing in stands of white oak and black oak could decline over time as forest succession follows the course expected with little to no disturbances from timber harvests or prescribed burning. On most sites, succession will favor the eventual dominance of the white oaks. The small pine component (yellow and white pine) is likely to decline. Understory species would not vary much except where the pine overstory is replaced by oaks. Without planting or some disturbance to expose mineral soil, white pine would gradually decline as a species in this type-group except on poorer sites where it may become stable with chestnut oak. When conditions that provide for adequate regeneration of oak are eliminated, oak could be replaced in the overstory by blackgum, locust, red maple, white pine, and some yellow pine as a result of gypsy moth and oak decline impacts.

The variety of overstory and understory plants existing in stands of red oak and red maple could change over time as forest succession with less disturbance follows the course expected. However, the change may not be as great as in the preceding type-groups. While undisturbed stands tend to develop greater proportions of species other than northern red oak, historically red oak has generally retained its dominance in most stands. Red maple is usually second in importance in both the overstory and understory of stands containing red oak. White pine is found on either the more exposed drier sites or along stream corridors generally in association with hemlock. The varied understory, herbaceous plants and ferns, and tolerant tree species should continue to maintain their presence, although changes could be abrupt within small microsites, from even minor disturbances in the overstory. Fire is less likely to affect this type group and will generally only affect the

understory. Oaks could be replaced almost entirely by tolerant maples as a result of severe defoliation by gypsy moth.

Habitat Fragmentation

Habitat fragmentation is a key issue for viability of local populations of breeding birds and other species like salamanders in some mature mesic deciduous forest settings. Birds in this group avoid forest edges during nesting and are adapted to forest interior conditions. Most are neotropical migrants that primarily nest and raise young in the temperate Americas. These species are grouped for effects analysis due to their sensitivity to forest fragmentation and edge effects (Hamel 1992).

Studies conducted in the mid-western U.S. have documented that forest interior species may not successfully breed in small patches of otherwise suitable habitat. Quality of their forest interior habitat is measured in part by proportion of edge, an artifact of juxtaposing forested and non-forested habitats. Edges fragment forest interior habitats and are associated with increased predation and brood parasitism by the brown-headed cowbird in agricultural settings (Primack 1993; Yahner 1998). However, characteristics of the surrounding landscape, such as percent forest cover, determine the magnitude of local edge effects. Findings of Robinson and others (1995) indicate that large landscapes with at least 70-80% forest cover offer high potential as quality habitat for forest interior species, where adverse effects of edge are reduced to levels compatible with productive populations.

Donovan and others (1997) found that abundance of the brown-headed cowbird in a midwestern U.S. setting was significantly greater in highly fragmented landscapes (< 15% forested) than in moderately fragmented (45-55% forested) or unfragmented (>90% forested) landscapes, but abundance in moderate and unfragmented landscapes did not differ. Landscape-scale habitat patterns significantly influenced overall nest predation patterns and cowbird abundance. However, local effects of livestock grazing and horse corrals caused high variation between landscape units with similar percent forest characteristics. The specific types of non-forested habitats present may be important.

As a general rule, parasitism levels of 25% or less and daily nest predation rates of 4% or less should give most forest interior species "at least a chance" (Robinson 1995) of having self-sustaining local populations (also May and Robinson 1985; Donovan et al. 1995). Based on the work of Robinson and others (1995), these parasitism rates are associated with a minimum of 70-80% forest cover at a landscape (75,000 acre) scale for a midwestern U.S. setting.

Duguay and others (2001) found that in a forested setting in West Virginia (Monongahela National Forest, >88% forest cover), "fifteen years after harvest, cuts placed within otherwise extensively forested areas do not result in the type of edge effects (population sinks) observed in areas fragmented by agriculture in the midwestern U.S." They also concluded that implementing relatively small cuts that create edge on a small proportion of the landscape may not result in increased nest failure, provided that other factors such as proximity to cowbird feeding sites are not prominent. The study involved tracking 556 nests of 46 species over a four-year period and calculation of daily nest survival rates.

Other habitat factors are known to influence productivity of this species group. Presence of young forest patches within a forested landscape is likely to have positive benefits for immature birds. Vega Rivera (1998) and Anders and others (1998) found that after fledging, juvenile wood thrushes disperse from mature forest habitats and enter early successional forests where they fed on invertebrates and fruit. Use of these habitats was very high relative to their availability. Later in the season, they shifted back into mature forest habitats. Fledglings preferred areas with dense understory and ground cover with species such as blackberry, sumac, and grape. Such areas may be provided by relatively small even-aged regeneration areas or by smaller dispersed canopy gaps. Scattered canopy gaps and associated dense understories likely were characteristic of old growth mesic deciduous forests. Open habitats such as pastures, old fields, and managed wildlife openings were rarely used.

The significance of National Forest System lands to this species group was analyzed at both regional and forest scales in the Southern Appalachian Assessment (SAMAB 1996b: 69-73). This analysis of forest interior habitat

focused primarily on patterns of land use (forested vs. non-forested) and measures of edge effects at a landscape scale. Based on this analysis, there are approximately 9 to 10.5 million acres of suitable habitat in the Southern Appalachian Assessment (SAA) Area with about 4.7 to 5.4 million acres (52%) located within tracts greater than 5,000 acres.

Approximately 70% of suitable habitat and 51% of the largest tracts are privately owned, while 23% of suitable habitat and 39% of the largest tracts are on national forest land. A notable difference is found within the Blue Ridge Mountains, where approximately 40% of suitable habitat and half of the largest tracts occur on national forest land. Within the SAA area, the majority of forest interior habitat occurs within the Blue Ridge Mountains, followed by the Northern Ridge and Valley/Cumberland Mountains. The Southern Ridge and Valley and Southern Cumberland Plateau have the smallest relative amount (SAMAB 1996b:73).

To determine the landscape context of the GWNF, a shifting window analysis was conducted using 1990 National Land Cover Data (U.S. EPA 2002). Percent forest cover within a surrounding landscape of 75,000 acres (per Donovan et al. 1997) was calculated for each 90-meter grid cell located on the national forest and nearby private land. For this analysis, Deciduous, Evergreen, and Mixed Forest, and Woody Wetlands were classified as forested lands. All other land cover types, including recent clearcuts (transitional cover type), were classed as non-forest cover. This analysis indicates the great majority of the GWNF occurs within a landscape that is more than 70 to 90% forested. A similar analysis was recently completed by the Nature Conservancy for the Central Appalachians. Termed landscape integrity analysis, TNC incorporated publicly available spatial data to analyze distance of forested habitat with known landscape disturbing features such as roads, residential and urban development, transportation corridors, and mining and other industries (Anderson et al. 2012). This analysis for the GWNF showed similar forested landscape patterns to the shifting window analysis.

There are several areas within the GWNF that have settings that are less than 70% forested, where edge effects could adversely affect productivity of forest interior birds and other species. In all cases, either urban and/or agricultural influences create a landscape that is less than 70% forested. The major river valleys of the Potomac and Shenandoah are largely privately owned and dominated by either residential and urban development, or agricultural activities.

The current conditions and expected conditions for each alternative are displayed in Tables 3B1-1 and 3B1-2. All of the alternatives protect the floodplain/riparian ecological system, but Alternatives B, C, E, F, G, H and I expand the width of the riparian corridor and so increase the area that will receive the riparian management objectives, desired conditions and objectives to protect, restore and maintain riparian resources. Alternatives B, C, D, E, F, G, H and I all prescribe direction for management of the caves and karstlands. Alternative C provides some level of increased protection of caves and karstlands due to the reduced level of ground disturbing activities. The spruce forests are protected in all alternatives, but the Laurel Fork wilderness recommendation in Alternatives C and F could impede restoration efforts aimed at actively expanding the spruce component of Laurel Fork.

None of the alternatives restore the other ecological systems to their LANDFIRE biophysical conditions. For example, LANDFIRE indicates that about 50 percent of area in the mid-late successional stage for oaks should have an open canopy structure, but the maximum that any alternative provides is about 12 percent after fifty years. However, the prescribed burning in Alternatives B, E, F, G, H and I move those systems closer to their appropriate structural conditions and vegetation composition by returning more acreage to its historic fire regime. Alternatives D and C also accomplish this, but at a slower pace. The timber harvest in Alternatives D moves the systems towards their LANDFIRE regeneration biophysical condition better than the other alternatives, with Alternatives A, B, E, G, H and I following behind. Alternative C relies solely on natural processes to achieve regeneration and open canopy conditions. The interspersed nature of GWNF lands with private lands, past and projected development on those lands, changes in the flora and fauna of the area, and past fire suppression efforts makes it extremely difficult for natural processes to perform at the scale they did before European settlement. Therefore, the ecological systems cannot be restored to their historical conditions without active management activities.

Tables 3B1-1 and 3B1-2 are based on prescribed fire levels of 3,000 acres in Alternative A, 7,400 acres in Alternative A[1], 12,000 acres and 5,000 acres in Alternative D, and 20,000 acres in Alternatives B, E, F, G, H

and I. Timber harvest levels are based on levels generated by the Spectrum model and are 2,400 acres in Alternative A, 700 acres in Alternative A[1], 3,000 acres in Alternative B, 0 acres in Alternative C, 4,258 acres in Alternative D, 1,800 acres in Alternative E, 1,000 acres in Alternative F, and 3,000 acres in Alternatives G, H and I.

Table 3B1-1. Ecological Systems – Indicators by Alternative at End of First Decade

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	Condition of Indicator at End of 10 Years									
			Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842											
Acres Burned at Desired Frequency	7%	83%	23%	28%	34%	34%	18%	13%	34%	34%	34%	34%
Caves and Karstlands	119,000											
Total Occurrences at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cliff, Talus and Shale Barrens	13,637											
Acres of Open and Open Canopy	2%	100%	10%	12%	35%	35%	18%	8%	35%	35%	35%	35%
Cove Forest	61,022											
Acres in mid to late successional stages	98%	96%	98%	100%	95%	100%	95%	95%	98%	95%	94%	95%
Acres of Regenerating Forest	2%	4%	2%	0%	4%	0%	5%	5%	2%	4%	5%	4%
Acres of open canopy in mid to late successional stages	1%	9%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Northern Hardwood Forest	13,478											
Acres in mid to late successional stages	98%	95%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Acres of Regenerating Forest	2%	5%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Acres of open canopy in mid to late successional stages	2%	10%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Oak Forests and Woodlands	756,058											
Acres in mid to late successional stages	95%	92%	94%	97%	94%	97%	92%	92%	95%	96%	93%	93%
Acres of Regenerating Forest	3%	8%	5%	2%	5%	2%	7%	7%	4%	2%	5%	5%
Acres of open canopy in mid to late successional stages	2%	50%	6%	8%	12%	2%	9%	7%	12%	12%	12%	12%

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	Condition of Indicator at End of 10 Years									
			Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Openings												
Acres of open grasslands or forbs	<1%	4%	0%	1%	1%	0%	1%	1%	1%	1%	1%	1%
Pine Forests and Woodlands	162,129											
Acres in mid to late successional stages	97%	91%	98%	98%	96%	98%	98%	98%	97%	96%	97%	97%
Acres of Regenerating Forest	3%	9%	2%	1%	3%	1%	2%	2%	2%	3%	2%	2%
Acres of open canopy in mid to late successional stages	3%	79%	5%	7%	12%	1%	8%	5%	12%	12%	12%	12%
Floodplains, Wetlands and Riparian Areas	51,430											
Compliance with Riparian Guidelines	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	582											
Total System Acres at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

Table 3B1-2. Ecological Systems – Indicators by Alternative at End of Fifth Decade

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	Condition of Indicator at End of 50 Years									
			Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Mafic Glade and Barrens and Alkaline Glades and Woodlands	3,842											
Acres Burned at Desired Frequency	7%	83%	41%	73%	67%	67%	38%	28%	67%	67%	67%	67%
Caves and Karstlands	119,000											
Total Occurrences at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cliff, Talus and Shale Barrens	13,637											
Acres of Open and Open Canopy	2%	100%	18%	34%	71%	71%	40%	20%	71%	71%	71%	71%
Cove Forest	61,022											
Acres in mid to late successional stages	98%	96%	98%	100%	95%	100%	95%	95%	98%	95%	94%	95%
Acres of Regenerating Forest	2%	4%	2%	0%	4%	0%	5%	5%	2%	4%	5%	4%
Acres of open canopy in mid to late successional stages	1%	9%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Northern Hardwood Forest	13,478											
Acres in mid to late successional stages	98%	95%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Acres of Regenerating Forest	2%	5%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Acres of open canopy in mid to late successional stages	2%	10%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Oak Forests and Woodlands	756,058											
Acres in mid to late successional stages	95%	92%	94%	97%	94%	97%	92%	92%	95%	96%	93%	93%
Acres of Regenerating Forest	3%	8%	5%	2%	5%	2%	7%	7%	4%	2%	5%	5%
Acres of open canopy in mid to late successional stages	2%	50%	6%	10%	19%	2%	13%	9%	19%	19%	19%	19%

Ecosystem and Indicator	Current Condition (acres)	LandFire Condition (% of area)	Condition of Indicator at End of 50 Years									
			Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Openings												
Acres of open grasslands or forbs	<1%	4%	0%	1%	1%	0%	1%	1%	1%	1%	1%	1%
Pine Forests and Woodlands	162,129											
Acres in mid to late successional stages	97%	91%	98%	98%	96%	98%	98%	98%	97%	96%	97%	97%
Acres of Regenerating Forest	3%	9%	2%	1%	3%	1%	2%	2%	2%	3%	2%	2%
Acres of open canopy in mid to late successional stages	3%	79%	5%	13%	21%	1%	13%	9%	21%	21%	21%	21%
Floodplains, Wetlands and Riparian Areas	51,430											
Compliance with Riparian Guidelines	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spruce Forest	582											
Total System Acres at Desired Condition	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

B2 – TERRESTRIAL SPECIES DIVERSITY

B2A - TERRESTRIAL VIABILITY EVALUATION

AFFECTED ENVIRONMENT

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in continued existence of the species well-distributed over time.

Because NFMA regulations require providing habitat for species viability within the planning area, focus of this evaluation is on habitat provided on national forest land. Surrounding private lands may contribute to, or hinder, maintenance of species viability on national forest land, but are not relied upon to meet regulation requirements.

Evaluation of migratory birds focused on breeding populations only, unless otherwise indicated. This focus does not mean that wintering and migrating populations were not considered during planning, but that viability evaluation makes most sense when viewed in terms of the relative stability of breeding populations.

Viability Evaluation Process

The ecological and species sustainability framework is built on the principle that by restoring and maintaining the key characteristics, conditions, and functionality of native ecological systems and by identifying and managing for additional needs for key species, the GWNF will be able to maintain and improve ecosystem diversity, provide for the needs of diverse plant and animal species on the forest, and provide management direction to support viable populations of native and desirable plants, fish and wildlife.

The Ecosystem Diversity Report (EIS, Appendix E) describes the analysis process used to identify, evaluate, and develop guidance for sustaining ecological diversity. The overall goal for ecological sustainability is to sustain native ecological systems and support diversity of native plant and animal species. Ecosystem diversity is defined as the variety and relative extent of ecosystem types including their composition, structure, and processes. The major characteristics of forestwide ecosystem diversity and descriptions of the 24 ecological systems found across the GWNF are presented in this Ecosystem Diversity Report.

While most plant and animal species' needs are expected to be met by sustaining ecosystem diversity, a corresponding species-specific analysis was also conducted to evaluate whether additional provisions were needed for federally listed species, sensitive species and locally rare species. This species-specific sustainability analysis is described in more detail in the Species Diversity Report (EIS, Appendix F). This report and the Ecosystem Diversity Report focus on the terrestrial environment. The analysis of the aquatic systems is covered in the Aquatic Ecological Sustainability Analysis (EIS, Appendix G).

The following steps were used to build an ecological sustainability framework. Each step is documented within the Ecological Sustainability Evaluation (ESE) tool, a relational database developed by the Forest Service and based on the structure used by The Nature Conservancy in their Conservation Action Planning. Although these steps are presented sequentially, the process required much iteration.

1. Identify and define ecological systems

To define terrestrial ecosystem diversity, all terrestrial ecological systems on the GWNF were identified using NatureServe's International Ecological Classification Standards (NatureServe 2005). Each system was defined in terms of existing Forest Service forest types and in terms of the LANDFIRE Vegetation Dynamic Models. Current acreage of each system was calculated using Forest Service GIS data. All identified terrestrial ecological systems were included in the ecological sustainability framework. These systems also relate to the Virginia Department of Conservation and Recreation Natural Heritage Program Vegetation Community types. The framework for diversity of aquatic ecological systems is described in the Aquatic Ecological Sustainability Analysis (EIS, Appendix G).

2. Identify stresses and threats to the ecological systems

Major stresses and threats to the ecological systems were identified.

3. Identify species

To assess species diversity, a comprehensive list of plant and animal species was compiled by combining species lists from a variety of sources. These sources included federally-listed threatened and endangered (T&E) species obtained from the U.S. Fish and Wildlife Service, Virginia Department of Conservation and Recreation Natural Heritage Program, Virginia and West Virginia State Comprehensive Wildlife Conservation Strategies, the Birds of Conservation Concern list compiled by the U.S. Fish and Wildlife Service, and the Forest Service's list of sensitive species. Species were then screened for inclusion in the framework. The criteria and process for identifying, screening and grouping species are detailed in the Species Diversity Report (EIS, Appendix F).

4. Identify stresses and threats to the species

Major stresses and threats were identified for each species in regard to their populations on the GWNF.

5. Identify and define characteristics of ecosystem diversity and related performance measures

To identify key characteristics and performance measures for terrestrial ecological systems, Forest Service biologists reviewed information in NatureServe, LANDFIRE, Virginia Department of Conservation and Recreation Natural Heritage Program community types, and other information.

6. Link species to the ecological systems and identify any additional needs of species

Species were then linked to terrestrial ecological systems. Where useful, species were grouped before linking them to systems. Where ecological conditions for these species were not covered by the ecosystem diversity framework, additional characteristics, performance measures, and rating criteria were added to the framework to cover these needs. All species have at least some of their needs covered by ecosystem diversity, but some species required additional plan components based on their major limiting factors. The ways in which individual species needs were addressed by ecosystem diversity components and additional Plan provisions are described in the Species Diversity Report (EIS, Appendix F).

7. Assess current condition of the indicators for the ecological systems and species groups

Current values and ratings of all performance measures were estimated using a variety of methods. Many current values were derived through analysis of existing GIS databases. Assumptions and methods for determining current values and ratings are recorded in the ESE tool.

8. Develop plan components to address the stresses and threats and provide management direction to maintain habitat components

In this step, plan components were developed to provide desired conditions, objectives, standards and guidance for managing ecosystem diversity and ecological conditions for species. These plan components were then linked with characteristics and conditions within the ESE tool. We ensured that all elements of the framework were addressed by appropriate management direction.

Twenty-three native ecosystems were identified for the GWNF using NatureServe's International Ecological Classification Standards (NatureServe 2004a, 2004b). A system was added to cover caves and karstlands. Current acreage of each system was calculated using Forest Service GIS data.

As we developed the ecosystem diversity analysis, we identified that many of the ecological systems had similar key attributes, indicators, species associates and resulting forest plan components. For purposes of analysis we combined the systems into the following Ecological System Groups:

Table 3B2-1. Ecological Systems

Ecological System	Ecological System Group
Central and Southern Appalachian Spruce-Fir Forest	Spruce Forests (approximately 600 acres)
Appalachian (Hemlock)-Northern Hardwood Forest	Northern Hardwood Forests (approximately 13,000 acres)
Southern Appalachian Northern Hardwood Forest	
Southern and Central Appalachian Cove Forest	Cove Forests (approximately 61,000 acres)
Northeastern Interior Dry-Mesic Oak Forest	Oak Forests and Woodlands (approximately 756,000 acres)
Central and Southern Appalachian Montane Oak Forest	
Central Appalachian Dry Oak-Pine Forest	
Southern Appalachian Oak Forest	
Southern Ridge and Valley/Cumberland Dry Calcareous Forest	
Southern Appalachian Montane Pine Forest and Woodland	Pine Forests and Woodlands (approximately 162,000 acres)
Central Appalachian Pine-Oak Rocky Woodland	
Southern Appalachian Low-Elevation Pine Forest	
Southern and Central Appalachian Mafic Glade and Barrens*	Alkaline and Mafic Glades and Barrens (approximately 4,000 acres)
Central Appalachian Alkaline Glade and Woodland*	
North-Central Appalachian Circumneutral Cliff and Talus*	Cliff, Talus and Shale Barrens (approximately 14,000 acres)
North-Central Appalachian Acidic Cliff and Talus*	
Appalachian Shale Barrens*	

Central Appalachian River Floodplain	Floodplains, Wetlands and Riparian Areas (approximately 51,000 acres)
Central Appalachian Stream and Riparian	
Central Interior Highlands and Appalachian Sinkhole and Depression Pond*	
Southern and Central Appalachian Bog and Fen*	
North-Central Appalachian Acidic Swamp*	
North-Central Appalachian Seepage Fen*	
Caves and Karstlands	Caves and Karstlands (approximately 119,000 acres)

The major stresses and threats to each of these systems were identified. Key attributes and indicators were identified for each of these systems to determine if the systems are performing to their desired conditions.

The GWNF started with statewide species lists compiled from a variety of sources including the Birds of Conservation Concern list, Virginia and West Virginia State Heritage Programs tracked plant and animal lists, Virginia and West Virginia State Comprehensive Wildlife Strategy species of greatest conservation need list, Regional Forester's Sensitive Species list, federally listed Threatened and Endangered Species, and demand species. The original list consisted of about 474 plant and animal species with ranges occurring throughout the states.

The EIS Appendix F lists the 97 species which were removed from the list because they did not occur or have potential to occur on NFS-administered land based upon suitable habitat, range, or expert taxonomic consensus. If these species are found to occur on the GWNF, they will be re-evaluated. Of the remaining species an additional 82 species were not analyzed further because: a) the species is unaffected by management; b) the Forest is of marginal importance to conservation of the species; c) knowledge of species' ecology is insufficient to support conservation strategy; d) species' taxonomy is too uncertain to develop conservation strategy; or d) species is common and demonstrably secure on the Forest.

The remaining 295 species are addressed in this analysis.

These species were placed in groups based on similar habitat needs or on similar management requirements. The major stresses and threats to each of these species were identified. Key attributes and indicators were identified for each of the species groups to evaluate alternatives and develop plan direction.

In addition to noting the Global and State ranks of each of the species, a unit rank, or rank of rarity on the GWNF was also assigned to each species. The U ranks are as follows:

Unit Rank	Unit Rank Description
U1	Critically Imperiled—Critically imperiled on the unit because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the unit.
U2	Imperiled—Imperiled on the unit because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the unit.
U3	Vulnerable—Vulnerable on the unit due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation on the unit.

U4	Apparently Secure–Uncommon but not rare; some cause for long-term concern due to declines or other factors.
U5	Secure–Common, widespread, and abundant on the unit.
UU	Unrankable–Species or system is known to occur on the unit, but is currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
UH	Possibly Extirpated (Historical)–Species or system occurred historically in unit, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or system could become UH without such
UX	Presumed Extirpated–Species or system is believed to be extirpated from the unit because it has not been located despite intensive searches of historical and other appropriate sites; there is virtually no likelihood that it will be rediscovered.
UP	Possibly Present--There are no known current or historical occurrences, but the unit is within the range of the species or system and there is some chance it may occur.
UNP	Not Present--Species or system is not known, and is not expected, to occur on the unit.
UNR	Not Ranked–A unit rank has not yet been assigned.
UNA	Not Applicable–A unit rank is not applicable because rarity or vulnerability is not the conservation issue for the species or system (e.g., cowbirds or invasive species).

Viability outcomes can be expressed in terms of the abundance and distribution of species or their habitat. By definition, all of the species that are being addressed (except for the demand species) have limited distribution and limited abundance on the GWNF. The ESE tool generated a priority ranking for all of the species based on the global, state and unit ranks.

Different strategies were used in different alternatives to address habitat needs of the species. The way the alternative affected the indicators for the ecological systems and the species groups are displayed.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Many of the risks to viability of species on the GWNF are related to factors outside the management direction for the Forest. Many of the species are at the limits of their ranges, utilize habitat from an area much larger than the Forest itself, or are affected by large scale influences like climate change. In these cases, the best that can be done on the GWNF is to maintain and restore resiliency in habitat conditions so that species have the ability to utilize the habitat to the extent they can.

Table H.1 in Appendix H displays each of the species evaluated, the global and unit conservation rankings and the species groups to which each species are associated. Outcomes for the attributes and indicators for the ecological systems are summarized in Tables 3B1-1 and 3B1-2. Outcomes for the attributes and indicators for the species groups are summarized in Tables 3B2-2 and 3B2-3. They are displayed for the current condition and for 10 years and 50 years of plan implementation under each alternative.

Tables 3B2-2 and 3B2-3 are based on prescribed fire levels of 3,000 acres in Alternative A, 12,000 acres in Alternative D, and 20,000 acres in Alternatives B, E, F, G, H and I. Timber harvest levels are based on levels generated by the Spectrum model and are 2,400 acres in Alternative A, 3,000 acres in Alternative B, 0 acres in Alternative C, 4,258 acres in Alternative D, 1,800 acres in Alternative E, 1,000 acres in Alternative F and 3,000 acres in Alternatives G, H and I.

Table 3B2-2. Terrestrial Species Groups – Indicators by Alternative at End of First Decade

Species Group and Indicator	Current Condition	Condition of Indicator at End of 10 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Alkaline Glades and Barrens	See Mafic and Alkaline Glades Ecological System										
Area Sensitive Grassland and Shrubland and Open Woodlands											
Total acres of area sensitive grasslands, shrublands or open woodlands	23,247	56,414	74,113	119,587	26,676	85,057	64,414	119,587	119,587	119,587	119,587
Shrublands > 40 acres	398	398	398	398	398	398	398	398	398	398	398
Area Sensitive Grasslands											
Area sensitive open Habitat grasslands greater than 100 ac	224	224	224	224	224	224	224	224	224	224	224
Area Sensitive Grasslands											
Area sensitive open habitat grasslands greater than 40 ac	389	389	389	389	389	389	389	389	389	389	389
Area Sensitive Shrubland and Open Woodlands											
Area sensitive open habitat shrubland and open woodland greater than 100 ac	22,569	55,736	73,435	118,909	25,998	84,379	63,736	118,909	118,909	118,909	118,909
Shrublands > 100 acres	109	109	109	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates											
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	898,162	890,272	912,998	884,844	913,891	871,957	871,957	896,272	904,925	885,149	884,849
Calciphiles											
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves	See Caves and Karstlands Ecological System										

Species Group and Indicator	Current Condition	Condition of Indicator at End of 10 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Cavity Trees, Den Trees and Snags											
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and Large Rock Outcrops											
Compliance with cliff, talus and large rock outcrop guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests	See Cove Forests Ecological System										
Fire Dependent and Fire Enhanced											
Acres burned at desired frequency in all systems	26,144	35,855	53,555	99,028	6,118	64,498	43,855	99,028	99,028	99,028	99,028
Grasslands											
Existing grasslands in open conditions	2,773	2,773	2,773	2,773	1,387	2,773	2,773	2,773	2,773	2,773	2,773
Total grasslands acres	2,773	3,886	4,240	5,149	1,904	4,458	4,046	5,149	5,149	5,149	5,149
Hard and Soft Mast Dependent											
Total shrubland acres	31,967	42,447	19,347	48,447	18,447	61,447	61,447	36,447	28,447	48,447	48,447
Regenerating forest, pine + oak	29,232	39,742	17,622	44,242	16,742	56,947	56,947	33,742	24,162	43,442	44,228
Mature Oak	650,442	630,526	651,696	628,526	652,526	613,321	613,321	637,536	649,156	627,836	627,050
Open canopy pine + oak	19,275	50,309	67,648	109,653	16,742	78,058	59,002	109,653	109,653	109,653	109,653
High Elevation Coniferous, Deciduous and/or Mixed Forests											
Total acres of oak, cove or pine ecosystems in mid-late succession at elevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312

Species Group and Indicator	Current Condition	Condition of Indicator at End of 10 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
High Elevation Openings, Grassy or Shrubby or Open Woodlands											
Total High Elevation Grassland acres	411	411	411	411	411	411	411	411	411	411	411
Total high elevation shrubland acres	151	151	151	151	151	151	151	151	151	151	151
Regeneration at high elevation	5,599	7,526	3,278	8,630	3,113	11,021	11,021	6,423	4,952	8,630	8,630
Late Successional Hardwood Dominated Forest											
Mature and late successional oak, cove and northern hardwoods	689,162	679,772	701,548	676,844	702,391	661,457	661,457	686,782	697,425	675,659	675,359
Lepidopterans											
Compliance with lepidopteran guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks	See Mafic and Alkaline Glades Ecological System										
Occurrence Protection											
Compliance with Species Occurrence Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands											
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	22,460	55,627	73,326	118,800	25,889	84,270	63,627	118,800	118,800	118,800	118,800
Regenerating Forests											
Regenerating forest, pine, oak, cove, northern hardwood systems	30,444	40,924	17,824	46,924	16,924	59,924	59,924	34,924	26,924	46,924	46,924
Riparian	See Riparian Ecological System										
Ruderal											
Compliance with ruderal species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Species Group and Indicator	Current Condition	Condition of Indicator at End of 10 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Sandstone Glades and Barrens											
Compliance with sandstone glades species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection											
Compliance with guidelines for over collection	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic											
Compliance with recreation traffic guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens	See Cliff, Talus and Shale Barrens Ecological System										
Shrublands											
Total shrubland acres	31,967	42,447	19,347	48,447	18,447	61,447	61,447	36,447	28,447	48,447	48,447
Total maintained Shrubland acres	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523
Species in a Special Biological Area											
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

Table 3B2-3. Terrestrial Species Groups – Indicators by Alternative at End of Fifth Decade

Species Group and Indicator	Current Condition	Condition of Indicator at End of 50 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Alkaline Glades and Barrens	See Mafic and Alkaline Glades Ecological System										
Area Sensitive Grassland and Shrubland and Open Woodlands											
Total acres of area sensitive grasslands, shrublands or open woodlands	23,247	63,278	107,916	191,191	32,777	129,231	87,207	191,191	191,200	191,191	191,191
Shrublands > 40 acres	398	398	398	398	398	398	398	398	398	398	398
Area Sensitive Grasslands											
Area sensitive open Habitat grasslands greater than 100 ac	224	224	224	224	224	224	224	224	224	224	224
Area Sensitive Grasslands											
Area sensitive open habitat grasslands greater than 40 ac	389	389	389	389	389	389	389	389	389	389	389
Area Sensitive Shrubland and Open Woodlands											
Area sensitive open habitat shrubland and open woodland greater than 100 ac	22,569	62,600	107,238	190,513	32,099	128,553	86,529	190,513	190,522	190,513	190,513
Shrublands > 100 acres	109	109	109	109	109	109	109	109	109	109	109
Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates											
Cove, spruce, pine, oak, northern hardwood and riparian ecological systems	898,162	882,514	993,786	863,259	998,078	788,388	788,388	916,563	965,265	857,706	857,280
Calciphiles											
Total High-Quality Habitat Type Acres	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823	6,823
Caves	See Caves and Karstlands Ecological System										

Species Group and Indicator	Current Condition	Condition of Indicator at End of 50 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Cavity Trees, Den Trees and Snags											
Compliance with den/cavity tree and snag guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cliff and Talus and Large Rock Outcrops											
Compliance with cliff, talus and large rock outcrop guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cove Forests	See Cove Forests Ecological System										
Fire Dependent and Fire Enhanced											
Acres burned at desired frequency in all systems	26,144	42,720	87,358	170,641	12,219	108,681	66,657	170,641	170,641	170,641	170,641
Grasslands											
Existing grasslands in open conditions	2,773	2,773	2,773	2,773	1,387	2,773	2,773	2,773	2,773	2,773	2,773
Total grasslands acres	2,773	4,023	4,916	6,581	2,026	5,342	4,501	6,581	6,581	6,581	6,581
Hard and Soft Mast Dependent											
Total shrubland acres	31,967	42,400	19,300	48,392	18,400	61,392	61,392	36,392	28,400	48,392	48,392
Regenerating forest, pine + oak	29,232	39,742	17,622	44,242	16,742	56,947	56,947	33,742	24,162	43,442	44,228
Mature Oak	650,442	611,059	716,909	601,059	721,059	525,034	525,034	646,109	703,959	597,609	593,679
Open canopy pine + oak	19,275	55,389	96,730	175,165	16,742	118,485	79,539	175,165	175,165	175,165	175,165
High Elevation Coniferous, Deciduous and/or Mixed Forests											
Total acres of oak, cove or pine ecosystems in mid-late succession at elevations >3000 feet	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312	156,312

Species Group and Indicator	Current Condition	Condition of Indicator at End of 50 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
High Elevation Openings, Grassy or Shrubby or Open Woodlands											
Total High Elevation Grassland acres	411	411	411	411	411	411	411	411	411	411	411
Total high elevation shrubland acres	151	151	151	151	151	151	151	151	151	151	151
Regeneration at high elevation	5,599	7,518	3,269	8,620	3,104	11,010	11,010	6,413	4,943	8,620	8,620
Late Successional Hardwood Dominated Forest											
Mature and late successional oak, cove and northern hardwoods	689,162	672,015	782,337	654,418	786,579	577,047	577,047	706,232	757,766	647,375	646,949
Lepidopterans											
Compliance with lepidopteran guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mafic Rocks	See Mafic and Alkaline Glades Ecological System										
Occurrence Protection											
Compliance with Species Occurrence Guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Open Woodlands											
Open canopy pine, oak, mafic, cliff, riparian, cove, northern hardwood systems	22,460	62,491	107,129	190,404	31,990	128,444	86,420	190,404	190,413	190,404	190,404
Regenerating Forests											
Regenerating forest, pine, oak, cove, northern hardwood systems	30,444	40,877	17,777	46,869	16,877	59,869	59,869	34,869	26,877	46,869	46,869
Riparian	See Riparian Ecological System										
Ruderal											
Compliance with ruderal species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Species Group and Indicator	Current Condition	Condition of Indicator at End of 50 Years									
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt D*	Alt E	Alt F	Alt G	Alts H and I
Sandstone Glades and Barrens											
Compliance with sandstone glades species guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Over-Collection											
Compliance with guidelines for over collection	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sensitive to Recreation Traffic											
Compliance with recreation traffic guidelines	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shale Barrens	See Cliff, Talus and Shale Barrens Ecological System										
Shrublands											
Total shrubland acres	31,967	42,400	19,300	48,392	18,400	61,392	61,392	36,392	28,400	48,392	48,392
Total maintained Shrubland acres	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523	1,523
Species in a Special Biological Area											
Special Biological Area Managed for the habitat needed by the species	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
*This version of Alternative D uses a level of prescribed burning of 5,000 acres per year

The following descriptions of the alternatives in relation to species groups are based on comparisons to the current conditions, so they do not include Alternative A.

Alkaline Glades and Barrens species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this alternative. In addition, key glades are established as Special Biological Areas for all alternatives.

Area Sensitive Grassland and Shrubland and Open Woodlands species group is addressed through maintaining existing large maintained grassland and shrubland conditions and expanding habitat through the prescribed burning program. All of the alternatives maintain existing conditions, but Alternatives B, D, E, F, G, H and I all expand open woodlands through prescribed burning with Alternative D achieving less than the others. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland conditions in this alternative.

Area Sensitive Grasslands species group is addressed through maintaining existing large maintained grassland conditions. All of the alternatives are expected to maintain the existing occurrences of this habitat.

Area Sensitive Shrubland and Open Woodlands species group is addressed through maintaining existing large existing shrublands and achieving the desired the desired conditions and management objectives for the cliff/talus/shale barren, mafic/alkaline glades, oak, pine and cove ecological systems in regard to regenerating forests and creation of open woodlands. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest and prescribed burning, with Alternative D at a slower pace of burning. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland and shrubland conditions in this alternative.

Area Sensitive Late Successional Coniferous, Deciduous and/or Mixed Forests species group is addressed through achieving the desired the desired conditions and management objectives for the spruce, oak, pine, riparian and cove ecological systems in regard to mature forest conditions. All of the alternatives respond similarly with a large percentage of the forest in this habitat type.

Calciphiles species group is addressed through the cave and karstland standards and through the establishment of Special Biological Areas for the most representative calciphile sites. All of the alternatives provide protection and management of this group in the same way.

Caves species group is addressed through the establishment of cave and karstland standards that are part of all of the alternatives. These standards are designed to protect the physical (including the hydrology), chemical and biological characteristics of the caves and karstlands. In addition, in Alternatives E G, H and I caves (and defined areas around the caves) identified by the Virginia Natural Heritage Program are established as special geologic areas.

Cavity Trees, Den Trees and Snags species group is addressed through the establishment of standards to protect cavity and den trees and snags when management activities will remove trees. Given the mature and late successional stage of most of the forest, this habitat type is well represented throughout the forest. All of the alternatives provide protection and management of this group in the same way.

Cliff and Talus and Large Rock Outcrops species group is addressed through the establishment of a standard to assess the impacts of any activities proposed in this habitat type on the species identified as part of this group. All of the alternatives provide protection and management of this group in the same way.

Cove Forests species group is addressed through the desired conditions and management objectives for the cove forest ecological system, and so is dependent upon management actions to move this system to its desired condition. Alternatives B, D, E, F, G, H and I all do this through timber management, though

Alternatives E and A do so at a slower pace. The lack of a timber harvest program in Alternative C limits the development of the diverse age and structural conditions to meet the desired conditions.

Fire Dependent and Fire Enhanced species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades, cliff/talus/shale barren, pine, and oak ecological systems in regard to are burned at desired frequency, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the active restoration of this habitat in this alternative which relies on naturally ignited fire to achieve restoration of fire communities.

Grasslands species group is species group is addressed through maintaining existing grasslands. All of the alternatives, except Alternative C, are expected to maintain the existing occurrences of this habitat. In Alternative C, maintenance of existing grasslands is reduced below current levels.

Hard and Soft Mast Dependent species group is addressed through maintaining existing shrublands and achieving the desired the desired conditions and management objectives for the oak, pine and cove ecological systems in regard to regenerating forests and the oak systems for mature forest. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, G, H and I. The lack of a timber harvest program in Alternative C limits the development of the soft mast component and could reduce the hard mast through oak stands aged past their prime acorn bearing years and through the replacement of oak with shade tolerant trees.

High Elevation Coniferous, Deciduous and/or Mixed Forests species group is addressed through maintaining the acreage of these forest types. All of the alternatives are expected to maintain the existing occurrences of this habitat.

High Elevation Openings, Grassy or Shrubby or Open Woodlands species group is addressed through maintaining existing grasslands and achieving the desired the desired conditions and management objectives for the oak, pine, northern hardwood and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, G, H and I. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Late Successional Hardwood Dominated Forest species group is addressed through achieving the desired the desired conditions and management objectives for the oak, northern hardwood and cove ecological systems in regard to late successional forest conditions. All of the alternatives respond similarly with a large percentage of the forest in this habitat type.

Lepidopterans species group is addressed through the establishment of standards to protect against impacts from spraying for gypsy moth and from prescribed burning. All of the alternatives provide protection and management of this group in the same way.

Mafic Rocks species group is addressed through the desired conditions and management objectives for the mafic/alkaline glades ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this alternative. In addition, key mafic rock locations are established as Special Biological Areas.

Occurrence Protection species group is addressed through the establishment of standards to guide review and assessment of activities that could affect species in this group. All of the alternatives provide protection and management of this group in the same way. Due to the fewer ground disturbing activities allowed in Alternative C, it is likely to have fewer potential impacts on these species.

Open Woodlands species group is addressed through achieving the desired the desired conditions and management objectives for the cliff/talus/shale barren, mafic/alkaline glades, oak, and pine ecological systems in regard to creation of open woodlands. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, with Alternative D at a slower pace of burning. The lack of a prescribed burning and timber harvest program in Alternative C limits the development of the open woodland conditions in this alternative.

Regenerating Forests species group is addressed through achieving the desired the desired conditions and management objectives for the oak, pine, northern hardwood and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, G, H and I. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Riparian species group is addressed through the establishment of standards to guide management of activities in riparian areas. Alternatives B, C, E, F, G, H and I provide protection and management of this group in the same way by expanding the riparian areas to the same level as the Fish and Mussel Conservation Plan used in the Jefferson Forest Plan. Alternative D only expands the riparian areas in watersheds that support Threatened and Endangered aquatic species.

Ruderal species group is addressed through the establishment of standards to manage the old home sites, roadsides, and old fields where members of the ruderal species group are found in conditions that maintain their open character. All of the alternatives provide protection and management of this group in the same way.

Sandstone Glades and Barrens species group is addressed through the establishment of Special Biological Areas for high quality examples of this habitat. All of the alternatives provide protection and management of this group in the same way.

Sensitive to Over-Collection species group is addressed through the establishment of standards to limit collection of the species in this group. All of the alternatives provide protection and management of this group in the same way.

Sensitive to Recreation Traffic species group is addressed through the establishment of standards to reduce impacts of recreation activities on the species in this group. All of the alternatives provide protection and management of this group in the same way.

Shale Barrens species group is addressed through the desired conditions and management objectives for the cliff/talus/shale barren ecological system, and so is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through prescribed burning, though Alternative D does so at a slower pace. The lack of a prescribed burning program in Alternative C limits the development of the open woodland conditions in this alternative. In addition, key shale barren locations are established as Special Biological Areas.

Shrublands species group is addressed through maintaining existing maintained shrublands and achieving the desired the desired conditions and management objectives for the oak, pine and cove ecological systems in regard to regenerating forests. This is dependent upon management actions to move these systems to their desired condition. Alternatives B, D, E, F, G, H and I all do this through timber harvest with Alternative D achieving the highest level and Alternative F a smaller level than B, E, and G. The lack of a timber harvest program in Alternative C limits the development of additional habitat for this group.

Species in a Special Biological Area group is addressed through the establishment of Special Biological Areas to protect rare communities. All of the alternatives generally provide protection and management of this group in the same way. However, recommended wilderness could affect Special Biological Areas. If an area were designated, the ability to provide management activity, if it were needed, could be prohibited, or made difficult to achieve.

The relative changes in habitat for each species are then displayed in Table H-2 in Appendix H based on the effects to the various species groups. The table shows species effects from the addition of standards to protect species and the effects from management actions proposed in the alternatives.

The table shows that almost all of the species benefit from each alternative, other than Alternative A, due to the additional species group protections that are common to all the other alternatives. About half of the species need management action to create the composition or structure of vegetation that they need. The needs of the other half are largely met through standards to protect their habitat. Many of the species that need the protection standards are riparian species. If the riparian species are not considered, then about three-quarters of the terrestrial species considered in the analysis, need some level of vegetation management. All of the alternatives provide a large portion of the forest in remote settings with little management activity. All of the alternatives except Alternative C provide for active vegetation management in the form of timber harvest and prescribed burning. The lack of this vegetation management in Alternative C makes it the only alternative that does not address the viability needs of all of the species on the Forest.

Despite similarities among Alternatives A, B, D, E, F, G, H and I, some differences in effects of alternatives are apparent. Since Alternative A continues current direction, it does not have the advantage of the additional protection and management guidance developed to support ecosystem and species diversity that is part of all of the other alternatives. Since Alternative D does not expand the riparian areas the same level as Alternatives B, C, E, F, G, H and I, it does not provide the same level of protection to the riparian species. Alternatives B, E, F, and G have similar levels of prescribed burning and Alternatives E, G, H and I have similar levels of timber harvest. Alternatives E, G, H and I provide the best mix of habitat management and habitat protection to create resilience and diversity of habitat to maintain viability of the species on the GWNF.

The data in Table H-2 can be summarized as descriptive viability outcome ratings. The data is summarized into the following categories.

Table 3B2-4. Categories of Outcome Ratings

Outcome Rating	Global and Unit Conservation Ranks Included in the Rating
Outcome A. Species is globally secure or apparently secure and it is reasonably distributed and relatively abundant on the Forest. Likelihood of maintaining viability is high.	G4 or G5 and U3 or U4
Outcome B. Species is globally secure or apparently secure. Species is potentially at risk on the Forest due to limited distribution. Therefore, likelihood of maintaining viability is moderate.	G4 or G5 and U1, U2, or UP/UH
Outcome C. Species is vulnerable globally, but is reasonably distributed on the Forest. Therefore, species viability on the Forest is moderate.	G3 and U3 or U4
Outcome D. Species is vulnerable globally and is potentially at risk on the Forest due to limited distribution. Therefore, species viability may be at risk.	G3 and U1, U2, or UP/UH
Outcome E. The species is imperiled or critically imperiled globally. Therefore, species viability may be at risk.	G1 or G2

The expected changes in viability ratings based on implementation of each alternative are displayed in Table 3B2-5.

Table 3B2-5. Number of Species Whose Viability Outcome Changes by Alternative

Viability Outcome Groups	Number of Species							
Indicator	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Outcome Group A								
Total in group		17	17	17	17	17	17	17
Benefit from direction for additional protection		12	12	12	12	12	12	12
Small improvements in habitat due to effects of management activities		2	0	8	2	4	2	2
Improvements in habitat due to effects of management activities		6	0	0	6	2	6	6
Reductions in habitat due to effects of management activities		0	8	0	0	0	0	0
Minimal change in habitat due to effects of management activities		3	3	3	3	5	3	3
Outcome Group B								
Total in group		188	188	188	188	188	188	188
Benefit from direction for additional protection		170	170	170	170	170	170	170
Small improvements in habitat due to effects of management activities		23	1	57	11	12	23	23
Improvements in habitat due to effects of management activities		36	0	2	36	34	36	36
Reductions in habitat due to effects of management activities		1	59	1	1	11	1	1
Minimal change in habitat due to effects of management activities		9	9	9	21	12	9	9
Outcome Group C								
Total in group		12	12	12	12	12	12	12
Benefit from direction for additional protection		12	12	12	12	12	12	12
Small improvements in habitat due to effects of management activities		2	1	4	1	2	2	2
Improvements in habitat due to effects of management activities		2	0	0	2	2	2	2
Reductions in habitat due to effects of management activities		1	4	1	1	1	1	1
Minimal change in habitat due to effects of management activities		0	0	0	1	0	0	0
Outcome Group D								
Total in group		44	44	44	44	44	44	44
Benefit from direction for additional protection		43	43	43	43	43	43	43
Small improvements in habitat due to effects of management activities		1	1	11	0	0	1	1
Improvements in habitat due to effects of management activities		10	0	0	10	10	10	10
Reductions in habitat due to effects of management activities		1	11	1	1	2	1	1
Minimal change in habitat due to effects of management activities		2	2	2	3	2	2	2
Outcome Group E								
Total in group		41	41	41	41	41	41	41
Benefit from direction for additional protection		41	41	41	41	41	41	41

Viability Outcome Groups	Number of Species							
Indicator	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Small improvements in habitat due to effects of management activities		2	0	7	1	1	2	2
Improvements in habitat due to effects of management activities		5	0	0	5	5	5	5
Reductions in habitat due to effects of management activities		0	8	0	0	1	0	0
Minimal change in habitat due to effects of management activities		2	1	2	3	2	2	2

Planning for, and evaluation of, species viability for forest plan revision has focused primarily on providing desired abundance and distributions of habitat elements, in compliance with NFMA regulations. Risks to species viability can be much reduced by additional provisions present in existing law and policy. These include specific consideration of effects to federally listed threatened and endangered species, those proposed for such listing, and Regional Forester's Sensitive Species; and in biological assessments and evaluations conducted as part of all national forest management decisions. These assessments and evaluations identify where additional protective measures are warranted to provide for continued existence of the species on national forest land. Projects that may affect federally listed or proposed species must be coordinated with the US Fish and Wildlife Service. In support of these requirements, these species are also often the focus of inventory and monitoring efforts.

Additional species-based provisions included in all Forest Plan alternatives supplement existing law and policy. All alternatives include general and species-specific provisions for federally listed species, developed through coordinated planning with the US Fish and Wildlife Service.

In conclusion, high-risk species/habitat relationships are primarily a result of historical influences that have reduced distribution and abundance of some habitat elements and species populations, and of future impacts from forest health threats. In general, effects of proposed management strategies are small relative to historical impacts and future external threats. In general, risks to species viability are minimized by forest plan revision alternatives that provide a balanced mix of low-disturbance and disturbance-dependent habitat elements. Some elements in this mix are best provided through passive management and protection, while others require active management for restoration and maintenance.

B2B – FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

Indiana Bat

AFFECTED ENVIRONMENT

The Indiana bat is a medium-sized, *Myotis* species. On March 11, 1967, the Indiana bat was listed as a federal endangered species under the Endangered Species Preservation Act (ESPA) of 1966. Species listed under ESPA carried over and became listed by the Endangered Species Act when it became law in 1973. A recovery plan for the species was completed on October 14, 1983. In October 1996, the Indiana Bat Recovery Team released a Technical Draft Indiana Bat Recovery Plan. In October 1997, a preliminary version entitled "Agency Draft of the Indiana Bat Recovery Plan," which incorporated changes from the 1996 Technical Draft, was released. Subsequently, an agency draft entitled "Indiana Bat (*Myotis sodalis*) Revised Recovery Plan" was distributed for comments in March 1999. A final revision has never been completed. The range of the bat has been divided into recovery units. The GWNF falls within the Appalachian Mountains Recovery Unit.

Critical habitat was designated for the species on September 24, 1976 and includes 11 caves and 2 abandoned mines in Illinois, Indiana, Kentucky, Missouri, Tennessee, and Hellhole Cave in Pendleton County, West Virginia. No critical habitat is on or near the Forest and Hellhole Cave is 12.6 miles west of the Forest. The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During winter, the Indiana bat hibernates in caves (and occasionally mines) referred to as hibernacula. Bats are often readily found and easily counted at this time. Census of hibernating Indiana bats is the most reliable method of tracking population trends rangewide. As such, the winter distribution of the Indiana bat is well documented. Less is known about the abundance and distribution of the species during the summer maternity season, and even less is known about its migratory habits and associated range. During summer months, maternity colonies of more than 100 adult females roost under sloughing bark of dead and partially dead trees of many species, often in forested settings (Callahan et al. 1997). Reproductive females may require multiple alternate roost trees to fulfill summer habitat needs. Adults forage on winged insects within three miles of the occupied maternity roost. Swarming of both males and females and subsequent mating activity occurs at cave entrances prior to hibernation (MacGregor et al. 1999). During this autumn swarming period, bats roost under sloughing bark and in cracks of dead, partially dead and live trees in proximity to the cave used for hibernation.

POPULATION

Based on winter surveys at Priority 1 and 2 hibernacula, plus data from Priority 3 and 4 hibernacula when available, the U.S. Fish and Wildlife Service reported in 2007 that the total population of Indiana bats was at a recent historic high of approximately 467,947 individuals (this total is still less than half the estimated population in 1960). The 2009 rangewide population estimate was 415,512 individuals, a decline of 52,435 from 2007. Reasons for the decline are unknown, but perhaps the decline was caused by White Nose Syndrome (WNS), which was causing severe bat mortality in some cave hibernating bats in the northeastern and eastern U.S. In January 2012, the January-February 2011 rangewide total was reported at 424,708, an increase of 9,196 bats, and a number comparable to the 2005 count of 425,372 individuals (USFWS 2012).

In 2011, there were 411 hibernacula considered extant, and 62 considered historic or uncertain (USFWS 2012). In 2007, Indiana bats were known to hibernate in approximately 281 hibernacula in 19 states (USFWS 2009). Based on 2011 survey data, Indiana had 52.5% of hibernating individuals, followed by Kentucky 16.6%, Illinois 13.2%, West Virginia 4.8%, New York 3.8%, Missouri 3.2%, Tennessee 3.0%, Ohio 2.3% and the remaining eight states with hibernacula (including Virginia) 0.6% (USFWS 2012). In 2011 the eighteen Priority 1A hibernacula contained 368,597 Indiana bats, or 87% of the total known population, and 36 of 53 hibernacula classified as Priority 2A&B contained 43,328 Indiana bats, or 10% of the total known population. The remaining 340 caves considered extant, Priority 3 or 4 hibernacula contained 12,783 bats, or 3% of the total population. The four hibernacula on or near the Forest – Starr Chapel, Mountain Grove, Clarks, and Hupman's Saltpetre Caves – are considered Priority 3 or 4 hibernacula.

Data on the Indiana bat has been collected in Virginia since the early 1960s, when the state's Indiana bat population was estimated at over 5,000. Dalton (1987) found 2,500 Indiana bats hibernating in eight caves during a 10-year survey of 170 caves in 22 counties. In 1997 the state's population was estimated to be 1,840 bats. Since 2001, the estimated number of bats in Virginia has remained relatively constant, at 700 – 1100 (Table 3B2-6). West Virginia, has seen a steady increase in bats during the past decade, from 10,000 to 20,000 bats.

Table 3B2-6. Estimated Indiana Bat Populations

State	2001	2003	2005	2007	2009	2011
Virginia	969	1,158	769	723	730	863
West Virginia	9,714	11,443	13,417	14,745	17,965	20,358

Population estimates of hibernating bats, provided by Rick Reynolds of the Virginia Department of Game and Inland Fisheries, suggest that bat populations in the four hibernacula on associated with the GWNF fluctuate

substantially. In general, however, caves with lower numbers of bats seem to maintain low numbers, while caves with higher numbers maintain relative higher numbers of bats (Table 3B2-7).

Four hibernacula are known to occur on, or within 2 miles, of the Forest. All four caves are gated to control human access. Bat numbers fluctuate from count-to-count, but caves with lower numbers of bats seem to maintain low numbers, while caves with higher numbers maintain relative higher numbers of bats (Table 3B2-7).

Table 3B2-7. Indiana Bats in Hibernacula on or Near the GWNF
(Caves with Primary and Secondary Cave Protection Areas on land managed by GWNF)
(Number of Bats Counted per Rick Reynolds - VDGIF)

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
1960	600			
1962	600			
1972	35			
1974	30			
1978	2			
1979	1			
1980	0			
1981		0		
1982	16	0		
1983	29			
1984				
1985	30			
1986		0	21	
1987	5		52	
1988			31	0
1989	36			
1990	37	5	22	26
1991	23			0
1992	38	23	0	220
1993	31	0		
1994	42	1	20	300
1995	60			
1996			0	225
1997	54			
1998		2		
1999	55		1	
2000				
2001		2		5
2002				

Winter Survey Year	Starr Chapel Cave	Mt. Grove Cave	Clarks Cave	Hupman's Saltpetre Cave
2003	67		47	4
2004				
2005	57		50	0
2006				
2007	68		49	
2008				
2009	61		48	
2010				
2011	74		64	3
2012	92		63	1

Blank cells = no survey done that winter.

Prior to 2003, there were no documented areas of Indiana bat maternity activity in West Virginia, although a juvenile male was captured during the maternity period in Nicholas County in 1999. This bat was not tracked so no additional information on the potential maternity usage in the area is available. In the summer of 2003, two post-lactating female Indiana bats were captured and tracked to roost trees in Boone County, West Virginia. These captures represented the first confirmed Indiana bat maternity activity in West Virginia. Surveys at this site during 2005 located two primary roost trees and resulted in a maximum emergence count of 73 bats. Maternity activity at this site has consistently been confirmed since then through annual surveys. In the summer of 2004, a second maternity colony of approximately 25 bats was confirmed through the capture and tracking of a lactating female Indiana bat. This colony was located adjacent to the Monongahela National Forest (MNF) in Tucker County and is located within 2 miles (3.2 km) of a known Indiana bat hibernaculum. The roost tree that the bats were eventually tracked to fell down the following summer. Subsequent surveys in the area have not been successful in capturing any reproductively-active females, although a number of male Indiana bats have been caught. The status of this maternity colony is unknown. A third maternity colony was documented as a result of surveys conducted in 2005 near Kanawha State Forest in Boone County. Emergence counts at the two identified primary roost trees documented a maximum count of 49 bats. In the spring of 2010, female bats tracked emerging from a hibernaculum in Pennsylvania were found to have established a roosting area just over the State border in Ohio County, West Virginia. A maximum of 58 bats were found to emerge from a roost tree in this area. In the summer of 2010, a pregnant female was captured in Wetzel County. Radio telemetry was not conducted on this bat, and follow-up surveys were not able to locate any additional Indiana bats, so no additional information on this maternity area is available. In July and August 2012, five female Indiana bats were captured in Brooke and Ohio Counties. Subsequent tracking and emergence counts documented a number of separate roost areas, and up to 26 bats flying out of an individual roost tree. These captures may represent a number of different maternity colonies within the northern panhandle of West Virginia.

In addition to these captures near potential or confirmed maternity colonies, individual male Indiana bats have been captured in numerous locations throughout the State in the following counties: Clay, Fayette, Nicholas, Pendleton, Preston, Pocahontas, Randolph, Raleigh, and Tucker. Three male Indiana bats were captured on another site on the MNF in Pendleton County in 2004. These bats were tracked to a roost tree and subsequent emergence counts on that tree revealed 23 bats. Surveys conducted since that time confirmed this area supports a bachelor male colony roost. In July 2012, a number of male Indiana bats were captured along the Kanawha/Fayette County line in the same area that the juvenile male was captured in 2010. These adult male bats were subsequently tracked to a number of roost trees, as well as to the underside of an Interstate Highway bridge that was later documented to have up to 89 Indiana bats roosting underneath. All the bats that were captured, tracked, or examined were found to be males, providing evidence of an extensive bachelor colony in the area. These captures of both male and female bats confirm that the Indiana bat uses forested

habitats throughout the State for summer foraging and roosting. The increase in captures after 2002 may not reflect an actual increase in densities of Indiana bats summering within the State; rather these results may reflect the fact that survey efforts in relation to project review and monitoring have increased in recent years.

MIGRATION

The timing of spring and autumn migration has been generally inferred as the time between when bats leave the hibernacula and when they are found in maternity areas (spring), and vice-versa (autumn). In most portions of the range, this is generally considered to be from 15 April to 15 May in spring, and 15 August to 15 November in autumn, although these dates are sometimes adjusted regionally to accommodate latitudinal differences in season. Essentially all acres within the Forest could serve as potential migratory Forest habitat for the Indiana bat.

Little is known about the habitat used by either sex during migration, although it is generally presumed to include a variety of wooded habitats. The following is an excerpt from the USDI Fish and Wildlife Service (1999) Revised Draft Indiana Bat Recovery Plan: "Although certain migration patterns may be inferred from limited band returns, they should be interpreted with caution. The sparse band recovery records, all of which are from the Midwest, indicate that females and some males migrate north in the spring upon emergence from hibernation (Hall 1962; Barbour and Davis 1969; LaVal and LaVal 1980), although there is also evidence that movements may occur in other directions. However, summer habitats in the eastern and southern United States have not been well investigated; it is possible that both sexes of Indiana bats occur throughout these regions. Very little is known about Indiana bat summer habitat use in the southern and eastern United States, or how many Indiana bats may migrate to form maternity colonies there. Most summer captures of reproductively active Indiana bats (pregnant or lactating females or juveniles) have been made between April 15 and August 15 in areas generally north of the major cave areas. While these observations suggest that many or most female Indiana bats in the Midwest migrate north in the spring and south in the fall, potentially significant numbers also migrate in other directions." When Indiana bats are captured in spring or autumn, especially when caught near a cave or mine, there is generally no way to determine why the bat was in the area. In West Virginia, a male juvenile caught on August 5, 1999 (Kiser et al. 1999) was likely migrating to a nearby hibernaculum. As noted above, Indiana bats hibernating in mountainous regions of West Virginia may travel to warmer areas in the western part of the state or states to the west to raise their young. Brack and others (2002) indicated that nursery colonies were less likely in higher elevations and areas of cooler temperatures. During a survey of coal mining operations in Wise County Virginia, a consulting firm documented use of an abandoned coal mine by a female Indiana bat on April 14, 2001 which may have been a migratory individual. During autumn swarming and spring staging, Indiana bats use the cave hibernacula and nearby wooded habitats. In autumn, use of woodlands decreases over time as bats enter hibernation. The converse is true in spring. Two recent telemetry studies documented use of a variety of habitats within 2 miles of two caves on the Jefferson National Forest. In late September 1999 four Indiana bats (3 males, 1 female) were trapped and fitted with radio transmitters at the entrance of Rocky Hollow Cave in Wise County. From September 23rd to October 13th (21 days) three roost trees were located (all on private land) that were used by two of the bats (one male and one female). The female used two different trees in open woodlands approximately 1.5 miles southwest of the cave near the Lonesome Pine Country Club. One was a shagbark hickory 19" DBH (diameter breast height) and the other was a yellow poplar with peeling bark that was next to a skid-road that had been damaged during a logging operation. The tree occupied by the male bat was used as a roost on multiple days and was a pignut hickory 27.9" DBH located 0.15 miles north of the cave. Other observations made during the course of the study included extensive foraging activity over hayfields and along edges of forests and fields.

McShea and Lessig (2005) conducted a study in April 2005 where thirteen female Indiana bats were fitted with radio transmitters while still in their winter hibernacula in Bath County, VA. They were released and followed closely with both ground and aerial telemetry in an attempt to track them to their unknown summer maternity roost sites. Radio tracking was conducted on a daily basis from the day of their release until their signal disappeared. All bats but one could be followed for up to three weeks and their flight paths were recorded mostly traveling north or south. Four roost trees were found along natural corridors of creeks and ridges and one was still occupied at the end of the study. Several of the bats were observed to travel large distances in a short amount of time. The major directions of travel were generally north and south, with only one bat flying east (into the Shenandoah Valley) and none flying west (over the higher mountain ridges into

West Virginia) following release from the winter caves. The bats were located mostly in line with ridges, suggesting that they use these corridors as flyways to follow for easy transportation routes. When they do decide to move the bats can cover large distances in a short amount of time. For example, one bat moved 50-miles south in four days and another moved 25-miles north in two days. The small size of the transmitters necessitated "direct line of sight" to locate the animals, so ground crews were only effective when near the animal or above the animal on a ridge. An aerial crew was a necessity in order to keep track of all individuals when they foraged at night and as the bats dispersed following release. The four roost trees found by McShea and Lessig had similar characteristics. All were large snags and three were along the forest edge (creek or road) where they received significant sunlight during April. All roost sites were within oak-dominated forest types. The three bats that ultimately left their roost trees only stayed in them a few days before moving elsewhere. The overall movement pattern suggests flying to a nearby roost tree, resting for a few days and then flying a long distance before resting again.

A study that started in the spring of 2012 tracked two female Indiana bats from their hibernacula on the Cumberland Plateau in Tennessee south to two locations. One location was on the Talladega National Forest in Alabama, and the other on a wildlife management area in Gilmer County, Georgia. Information is still being gathered, but the tracked bat on the Talladega National Forest is roosting with approximately 25 to 30 other Indiana bats in an old woodpecker cavity in a dead loblolly pine on the Shoal Creek Ranger District. Both bats and associated roost trees are in an area where recent management has occurred, including thinning and prescribed burning.

There is limited data in WV that can make an overall assessment of Indiana bat migration patterns. This is based on numerous returns from bats who were banded in the non-hibernation period (spring, summer, or fall) and then later recovered during hibernation in the same county where they were banded, indicating that many bats will stay in the vicinity of their hibernacula. The following band returns from bats that moved outside the vicinity of their hibernacula into another county for the summer. Some of the bats went north (movement to Greene Co., PA was frequent) both others went south.

Summer Capture Location	Winter Capture Cave/Location
Greene Co., PA	Cliff Cave, Pendleton Co., WV
Greene Co., PA	Big Springs Cave, Tucker Co., WV
Greene Co., PA	Izaak Walton Cave, Randolph Co., WV
Greene Co., PA	Hellhole, Pendleton Co., WV
Somerset Co., PA	Hellhole, Pendleton Co., WV
Nicholas Co., WV	Hellhole, Pendleton Co., WV
Tucker Co., WV	Hellhole, Pendleton Co., WV
Pocahontas Co., WV	Minor Rexrode Cave, Pendleton Co., WV

There are at least four abandoned mines in WV that are being used by Indiana bats in the late fall swarming period, indicating that they are likely being used as hibernacula.

MATERNITY COLONIES

During summer, reproductive females form maternity colonies in trees. Maternity colonies may form hundreds of miles from the hibernacula, and females from a maternity colony may come from more than one hibernaculum. In contrast, males often use wooded areas near the hibernaculum, occasionally visiting the hibernaculum throughout the summer. Males sometime migrate long distances to summer habitat, although they tend to be less migratory than females, and often, though not always, remain geographically close to the hibernacula. During this time, males often roost individually, and likely use trees similar in character to those used near hibernacula in autumn and spring. Wooded lands closer to hibernacula are more likely to support

males in summer than areas farther away, but essentially all of the Forest may provide suitable summer habitat.

The core summer range of the Indiana bat is southern Iowa, northern Missouri, northern Illinois, northern Indiana, southern Michigan, and western Ohio. West Virginia is within the eastern maternity range, but not within the core range. Maternity colonies are known to occur in some eastern states, such as Kentucky and North Carolina, but, to date, none have been found in Virginia or neighboring areas in other states.

During a previous study in the summer of 1995, six male Indiana bats were captured in Tucker County, West Virginia. These captures represented the first documented summer use in West Virginia by Indiana bats, and suggest that males in West Virginia use areas near the hibernacula during summer. Until 2004 the best evidence of maternity activity in West Virginia was the discovery of a juvenile male on August 5, 1999. This is outside the defined maternity period and likely represents a juvenile migrating to a nearby hibernaculum. Then during the summer of 2004 surveys found a maternity colony estimated at 25 Indiana bats in Tucker County, West Virginia within two-miles of a known hibernaculum (USFS 2009). That same summer three male Indiana bats were captured on the Monongahela National Forest in Pendleton County and tracked to a roost tree where 23 other bats were subsequently counted (USFS 2009). To date no maternity colonies or reproductive female Indiana bats have been captured in Virginia during the summer reproductive season. In summer 1993, Chris Hobson of the Virginia Division of Natural Heritage surveyed areas of Bath, Bland, Highland, Lee, Tazewell, and Wise counties in proximity to known hibernacula. No female Indiana bats were captured and seven males were captured at five sites. One of the males, captured on July 28, 1993 in Cumberland Gap National Historic Park, Lee County, was a juvenile, suggesting that a maternity colony may be located in the Cumberland Gap area of Virginia, Kentucky, or Tennessee. These captures are the only documented summer Indiana bat occurrences in Virginia and suggest that males, at the least, use areas near the hibernacula during summer in western Virginia (Hobson 1993). Brack and others (2002) analyzed summer netting efforts 1995 to 2000 to identify summer reproductive populations in Virginia, West Virginia, and portions of Pennsylvania considered within the summer range of the Indiana bat. Over 3,000 net nights of effort failed to produce evidence of any maternity colonies.

SUMMER FORAGING

Due to the variability of known roost sites and the lack of knowledge about landscape-scale habitat characteristics, it is difficult to quantify summer roosting habitat for Indiana bat at a range-wide, regional, or local level. Forest management practices that affect occupied roost trees may have local impacts on Indiana bat populations. Across the historic range of the Indiana bat vegetation disturbances are prevalent and the species depends on an ephemeral resource (standing snags; living, dead or dying trees with cavities and/or exfoliating bark). Anecdotal evidence suggests that Indiana bats may benefit from limited disturbance around potential roosting areas (Menzel et al. 2001). Limited disturbance can create potential roost trees and open the canopy around potential roost trees (Gardner et al. 1991; Kurta et al. 1993). Indiana bats may be resilient to minor perturbations on the landscape such as targeted forest management and prescribed fire. General standards that would help ensure adequate roost habitat include retention of snags and suitable roost trees whenever possible, prescribed burning to restore and maintain open midstory foraging conditions (using only cool season backing fires in karst areas), and ensuring a continuous supply of oaks, hickories, and yellow pines as well as other trees with exfoliating bark (Menzel et al. 2001).

FALL SWARMING

Indiana bats may use caves and mines during the non-maternity season (autumn through spring) for one of several reasons: 1) winter hibernation; 2) autumn swarming; 3) spring staging; and 4) vagrant or migratory use. Autumn swarming and spring staging typically occur in woodlands near the hibernacula, with use of the hibernacula increasing as autumn progresses towards winter, and decreasing as spring progresses towards summer. Hibernacula tend to have higher use in spring and autumn, and larger winter concentrations typically produce greater spring and autumn use.

During autumn, when Indiana bats swarm and mate at hibernacula, male bats roost in trees nearby during the day and fly to the cave or mine at night. Work in Missouri (Romme et al. 2002) and Kentucky (Kiser and Elliott

1996; Gumbert 1996) have found that Indiana bats range up to 5 miles from hibernacula during autumn and spring swarming activity periods. In Kentucky, Kiser and Elliott (1996) found male Indiana bats roosting primarily in dead trees on upper slopes and ridgetops, within 1.5 mi of their hibernaculum. In West Virginia, some male Indiana bats roosted within 3.5 mi of their cave, in trees near ridgetops, and often switched roost trees from day to day (C. Stihler, West Virginia Division of Natural Resources, pers. observ., October, 1996). One Indiana bat in Michigan roosted 1.4 mi away from the hibernaculum during fall swarming, and another chose trees at a distance of 2.1 mi (Kurta 2000). Gumbert (2001) found an average of 1.2 mi between roost trees and the hibernaculum for 20 radio-tagged Indiana bats. Brack found a range of 0.18 to 0.87 mi between roost trees and a hibernaculum in Virginia, although he did not follow bats if they left the "project area" and the range may actually be greater. Based on terrain and landscape characteristics of these areas (generally rolling without great vertical relief) when compared to the Ridge and Valley terrain of Virginia (mountainous with vertical relief 1,300 to 2,500 feet) it is likely Indiana bat activity in this portion of the Appalachians is confined to the valley in which the hibernaculum occurs and may extend into adjacent valleys via gaps in the surrounding ridges or mountains.

During September and October of 2000 an extensive survey was made of fall swarming activity near Newberry-Bane Cave in Bland County, Virginia as part of the proposed American Electric Power (AEP) 765 kV Wyoming (WV) to Jacksons Ferry (VA) powerline project. This work was conducted by Virgil Brack of Environmental Solutions and Innovations, Cincinnati, Ohio and is documented in the Appendix to the Biological Assessment for the EIS associated with that project. Of 27 Indiana bats captured (24 males and 3 females) at the mouth of Newberry-Bane Cave, 17 (14 males and 3 females) were fitted with transmitters. Radio-tagged bats were monitored between September 9th and October 21st within 2-miles of the cave entrance.

The Brack study found that Indiana bats most frequently foraged over agricultural land (44.7%), intermediate deciduous forests (22.6%), and open deciduous forests (19.0%) habitats types, comprising 86.3% of all habitat types used for foraging during the survey. The bats' activity areas included proportionally more agricultural lands and open forests than was available in the study area. Closed canopy woodlands were not used by foraging bats to the extent they were available. This study concluded that Indiana bats more frequently used rights-of-way, pasture edges, savannah-like woods, and other openings rather than large, continuous tracts of closed canopy forests. These findings are consistent with the interpretation of telemetry data in similar studies.

For roosting ecology the study by Brack found a total of 26 roost trees for 8 of 17 bats fitted with transmitters. Of the 26 roost trees, 39% were shagbark hickories (*Carya ovata*) and 12 % northern red oak (*Quercus rubra*), for a total of 51%. Other tree species used as roosts included white oak (*Quercus alba*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), American basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*). Five (19%) of the roost trees were dead snags. All roost trees were located in close proximity to the cave entrance ranging from 0.16 to 0.86 miles, with an average distance of 3,280 feet (0.6 miles). All roost trees were located near forest canopy openings such as open woodlands of pastures, scattered trees of recently logged areas, old logging roads, utility line corridors, and natural drainages. Five of the eight bats used the same roost tree for two to three consecutive days. Roosts were located in all types of deciduous forests, but exhibited a disproportionately small use of mixed evergreen and deciduous forests. Roost trees were very exposed with little or no canopy shading by other trees. It is likely that in doing so the bats were taking advantage of exposure to solar radiation in order to better regulate body temperature. Many open-canopy areas existed due to recent logging activity that left scattered trees within the harvested areas. Roosts in closed canopy deciduous forests were often in small openings near open corridor flyways.

While much of the activity observed during the study was close to the cave (within approximately 0.6 mile) bats also left the 2-mile study area all together. Males more so than females tended to range further from the cave. Perhaps they would leave to forage where there was less competition for prey (the caves in the area serve as hibernacula for over 8,000 individual bats of at least five different species) and return to the cave area periodically to mate. It's therefore likely roosting and foraging activity also occurred outside this 2-mile area but all documented roost trees and foraging behavior observed were within two miles of the Newberry-Bane cave.

HIBERNACULA

Indiana bats tend to hibernate in the same cave or mine at which they swarm (LaVal et al. 1976; C. Stihler, pers. observation, October 1996), although swarming has been observed at hibernacula other than those in which the bats hibernated (Cope and Humphrey 1977). It is generally accepted that Indiana bats, especially females, are philopatric, that is, they return annually to the same hibernaculum (LaVal and LaVal 1980). Most bats of both sexes enter hibernation by the end of November (mid-October in northern areas–Kurta et al. 1997). Indiana bats hibernate in large, dense clusters, ranging from 300 bats per square foot to 484 bats per square foot (Clawson et al. 1980; Hicks and Novak 2002).

Caves must possess certain characteristics to be suitable as Indiana bat hibernacula. Raesly and Gates (1986) compared microhabitat and microclimate variables between occupied and unoccupied caves and mines. They found that Indiana bat hibernacula tended to have larger openings, more cave passage length, and higher ceilings compared to unoccupied sites. In addition, occupied hibernacula have noticeable airflow (Henshaw 1965). Once Indiana bats enter hibernation, they require specific roost sites in caves or mines that reach appropriate temperatures (Tuttle and Taylor 1994). Indiana bats choose roosts with a low risk of freezing. Stable low temperatures allow the bats to maintain a low metabolic rate and conserve fat reserves until they are ready to emerge in spring; thus, Indiana bats select roosts within hibernacula that best meet their needs for cool temperatures. Indiana bat hibernacula usually host other species of bats. Indiana bats are occasionally observed clustered with or adjacent to other species, including gray bats (*M. grisecens*), Virginia big-eared bats (*Plecotus townsendii virginianus*), little brown bats and northern longeared Myotis (Myers 1964; LaVal and LaVal 1980; Kurta and Teramino 1994).

NEW THREATS

Additional recent threats include White Nose Syndrome (WNS) and commercial scale wind power development. WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009 with additional spread and caves now contaminated. To date well over 1-million bats have been killed by this fungus which irritates bats during hibernation causing them to wake and use precious fat reserves. The bats then starve and or freeze when they attempt to fly and leave the cave in search of food during the midst of winter conditions.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode. Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Effects to the federally endangered Indiana bat (*Myotis sodalis*) were considered because there are hibernacula on and near the Forest, plus it is assumed the entire Forest is potential roosting and foraging habitat for this species. Potential effects include direct effects on hibernacula and effects on foraging and roosting habitat. The main management tool used in the Forest Plan to protect and manage habitat for the Indiana bat is the continued use of a management prescription area with an emphasis on the Indiana bat. This management area is located around the four caves known to contain the Indiana bat. This prescription area is established to: 1) protect hibernacula (caves in which the bats spend the winter); 2) maintain and enhance upland and riparian swarming and foraging areas; and 3) identify and protect summer roosting and maternity site habitat.

Management activities can degrade Indiana bat habitat if implemented in an unrestricted manner, therefore all alternatives continues to employ standards that apply to vegetation management across the entire forest to protect roosting and foraging habitat. Alternatives B, C, D, E, F, G, H and I also expand the areas defined as

riparian corridors, providing additional protection to vegetation in the riparian corridors which have been reported to be important foraging areas.

EFFECTS ON HIBERNACULA

Steps have been taken by the Forest to protect and maintain these caves as suitable for the Indiana bat. Since 1995, bat gates have been installed on all caves known to be used by endangered bat species on the Forest. Starr Chapel Cave and Mountain Grove Cave on the Warm Springs Ranger District in Bath County are the only caves with entrances on Forest land that serve as hibernacula for Indiana bats. Clarks Cave and Hupman's Saltpeter Cave are on private land, but within 2-miles of National Forest land. The Indiana Bat Primary Cave Protection Area is defined by a radius of no less than one half mile around each hibernaculum, defined by national forest surface ownership and topography. This area is intended to protect the integrity of the cave and the immediate surrounding uplands where bats may swarm and forage in the fall. Commercial timber harvest, road construction, and creation of new wildlife openings are prohibited. Prescribed burning, tree cutting, and road maintenance are evaluated in terms of effects on the Indiana bat before approval. This area is unsuitable for wind energy development. Two Indiana bats were found to have WNS during an April 21, 2010 cave survey conducted by Rick Reynolds (VDGIF) and Wil Orndorff (VDCR) in Starr Chapel Cave. This represents the first time Indiana bats have been documented with WNS on the Forest. Indiana bats occur in other caves infested with WNS, and where other bat species have been found infected, but individual Indiana bats in those other caves have not shown signs of WNS infection. Caves with significant bat populations on Forest land will continue to be gated and locked year-round. Currently, a Regional Forester closure order is in effect that closes all caves and mines year-round on National Forest lands to human intrusion. If and when access is needed, WNS protocols will be followed that should eliminate contamination from other caves.

EFFECTS ON ROOSTING OR FORAGING HABITAT

The Indiana Bat Secondary Cave Protection Area is defined by a radius of approximately 1½ miles around each primary cave protection area, defined by easily recognizable features on the ground. This configuration of the two protection areas provides management direction to protect and enhance the two-mile area around the hibernacula that is most critical to fall swarming. This secondary area is designed to further maintain and enhance swarming, foraging, and roosting habitat. Timber harvest, prescribed burning, wildlife habitat improvement, road construction, trail construction, and special uses may occur following evaluation of the effects on Indiana bats. Vegetation management is allowed to enhance foraging conditions. Timber management activities are suspended during the fall swarming season. The area is unsuitable for wind energy development.

Potential roosting habitat (mature forests with trees having exfoliating bark) exists across the entire Forest and contains tree species of the size and type known to be used by the Indiana bat. The retention of some snags, shagbark hickory, and hollow trees (as available) will allow for potential Indiana bat roost sites. Decreasing canopy closure as occurs with timbering and prescribed fire activities will increase the degree of exposure of some potential maternity roost trees to solar radiation, providing improved thermal conditions for raising young during a wide range of weather conditions. Pond/waterhole construction will increase the number of upland water sources available for Indiana bats. Persistence of early successional habitats and forests with an open understory and patchy overstory would create favorable foraging areas and flight corridors leading to potential roost trees. Harvesting would produce a mosaic of regeneration areas intermixed with mature and late successional forests. Likewise, prescribed fire would also create a mosaic of forest successional stages from early to late resulting from varying fire intensities associated with topographic features, vegetative types, and fuel accumulations. This will indirectly provide feeding areas since bats are known to forage within the canopy openings of upland forests, over clearings with early successional vegetation, and even along the borders of croplands, or wooded strips (fencerows), and over ponds. In contrast, negative impacts to the Indiana bat will be: (a) the slight chance that individuals or small groups of roosting bats (including summer maternity colonies if present) could be unintentionally killed by the felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bats which would be incurred on regeneration cuts immediately after harvest. Although the likelihood is very low, tree cutting activities could result in the inadvertent loss of

individual Indiana bats or small groups of Indiana bats via removal of some large-diameter hardwood trees occupied by bats during the period from approximately April 1 to October 15. Occupied and potential roost trees could be directly affected by vegetation management, firewood and salvage sales, routine maintenance/permitting of small clearings including easements, rights-of-way and access to privately-owned lands, and road construction. Plan implementation will result in vegetation disturbance and possible impact to currently occupied and potentially occupied roost trees. There is potential for adverse effects to a maternity roost tree if one occurs on the Forest and in an area where trees are being felled. However, forestwide standards minimize, if not eliminate, the chance of adverse effects under all alternatives. Any Indiana bat roosts that are discovered would be protected until they were no longer suitable (unless treatments were needed for public or employee safety) under all alternatives.

The National Forest fuelwood program allows the public to purchase and collect wood, often recently downed or standing/leaning dead trees, for personal use. The program is regulated by issuance of an area-specific permit and collection occurs primarily along roadsides and other specified sites with easy access. Vehicles must remain on open roads are not allowed to travel through the forest in order to facilitate finding, cutting, and loading firewood. This, therefore, restricts the distance at which most people are willing to cut and haul firewood and results in firewood being cut within 150 feet (about two tree lengths) of an open road, and is limited almost exclusively to level terrain or the uphill side. Volume of firewood cut on the Forest during 2008 was 4,488 CCF (hundred cubic feet) and during 2009 5,256 CCF, for an average of 4,872 CCF over the two-year period. A 14" DBH tree contains approximately 0.5 CCF of firewood; therefore approximately 9,744 dead trees were cut for firewood each year. The number of standing dead trees on the Forest can be calculated based on analysis of data collected during the 2002-2007 Forest Inventory and Analysis conducted by the Southern Forest Research Station, Asheville, NC and published in 2009. The number of dead standing trees at that time was 14.9 per acre for all trees larger than 5" DBH and 6.1 per acre for trees larger than 9" DBH. Given that the Forest is approximately 1.1 million acres, this equates to at least 6.5 million dead standing trees >9" DBH. All portions of the Forest continue to be infested with gypsy moths and infestations are forestwide with cycles of defoliation and mortality resulting from population fluctuations of gypsy moths. The result of these infestations is extensive areas of hardwood (especially oak) mortality in the overstory. Therefore, if 10,000 standing dead trees are cut each year for firewood, this equals 0.15% of the total available standing dead trees. Since most of these dead trees are not close to roads or are in Management Prescriptions where firewood cutting is not allowed, the possibility of harming an Indiana bat is extremely remote. In addition, most Indiana bats roost in live trees. Brack and Brown (2002) reported 81% of roost sites used by radio-tagged Indiana bats were live trees and 19% were snags. The odds of encountering a roosting bat are even further reduced since only dead trees are available for cutting as firewood and these dead trees represent perhaps 20% of the trees where they roost. Assuming this trend represented Indiana bat roost selection throughout the Forest, personal use firewood collection could affect 0.0003% of the potential Indiana bat roost trees. Firewood collecting is not allowed in the Primary and Secondary Indiana Bat Cave Protection Management Prescription Areas, ensuring that snags near hibernacula are retained. Although the risk of "take" resulting from firewood cutting cannot be completely eliminated, the risk of direct effects to roosts in the vicinity of hibernacula is further minimized since the collection of firewood in the Primary and Secondary Indiana Bat Cave Protection areas is not allowed by prescription standard. Some minimal risk of taking a bat roosting in a standing dead tree cut for firewood elsewhere on the Forest would continue to exist. However, given the relatively low number of Indiana bats on the Forest when compared to the number of acres, standing trees and snags, the use of any individual dead tree as a roost is likely to be brief, and the likelihood of take from firewood cutting is extremely small under all alternatives.

Most types of timber harvest (salvage, even-aged, uneven-aged, etc.) would require some snag and potential roost tree retention, plus specific retention of leave trees such as shagbark hickories. Forestwide standards in all alternatives require stand regeneration treatments greater than ten acres in size, retaining a minimum average basal area of 15 square feet per acre of live trees, and giving priority to retaining the largest available trees that exhibit characteristics favored by roosting Indiana bats (sloughing bark, cracks and crevices).

To maintain flight and foraging corridors in upland and riparian areas, a Conservation Recommendation in the 1997 Biological Opinion encouraged the Forest to increase its prescribed burning program on lands unsuitable for timber harvest. Over the past 15 years, the Forest has steadily increased its prescribed burn program. Alternative E would have the highest acres with 20,000 acres estimated to be prescribed burned each year.

Alternatives B, F, G, H and I have an objective to burn 12,000 to 20,000 acres per year. Prescribed fire is used for ecosystem restoration, wildlife and rare species management, site preparation and oak-pine regeneration. Most prescribed burns occur from March to mid-May, with a few during late May and June. Depending on weather and fuel conditions, a few may occur in late October and November. Control lines consist of existing roads, trails, and streams wherever possible. In areas where control lines need to be constructed, handtools and/or bulldozer will be used to dig a two to five foot wide strip to mineral soil. Some trees will need to be felled during line construction, but in most cases larger trees will be avoided with the line going around and between the largest trees. Some standing trees and snags near the line will be felled because they pose a hazard to personnel, or may burn and fall across the line, potentially spreading the fire into areas not scheduled for burning.

Some of the ridgetops on the GWNF have been identified as having potential for developing wind energy. The total area with a potential rated as fair to superb is about 117,000 acres. Plan Alternatives C and E do not allow for commercial wind power development. Alternatives B, D, F, G, H and I allow for consideration of wind power development. Alternatives B, F, G, H and I assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently, there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

Cumulatively, with implementation of any alternative, the Forest will maintain a supply of snags, live potential roost trees, upland water sources, and other habitat features across the landscape to allow for the maintenance, and promote the recovery, of Indiana bat populations. At the same time, activities can still continue to meet other multiple-use objectives. For example, timber harvesting can still occur to accomplish sufficient forest regeneration to provide diverse insect productions and provide for the continuation of diverse forest conditions across the Forest. Overall, there will be both potential benefits and potential impacts to the Indiana bat from management activities on the Forest. From a beneficial standpoint, the retention of most snags, all shagbark hickory, and hollow trees in sale areas would allow potential Indiana bat roost sites to be conserved; the reduction of canopy closure in sale areas and along unit margins would increase the degree of exposure of potential roost trees to solar radiation, providing improved thermal conditions for roosting and perhaps raising young; pond/waterhole construction would increase the number of upland water sources available for Indiana bats along with other bat species. Slightly positive benefits for Indiana bat would result as harvested units create insect-rich foraging areas and flight corridors leading to any tree roosts that might be present there. Positive benefits would result from prescribed burning by decreasing understory vegetation density and reducing canopy closure plus favoring oak, yellow pines, and hickory while reducing the in-growth of yellow poplar, red maple, and white pine. Positive benefits will also be realized from the application of prescriptions and associated standards focused on protecting caves and managing vegetation structure and conditions within 2-miles of hibernacula.

Contrastingly, negative impacts to the Indiana bat would be: (a) the slight chance that individuals or small groups of roosting bats (including possible summer maternity colonies) could be unintentionally killed by the intentional felling of trees harboring undetected roosts (e.g. dead limbs with loose bark, or small cavities in the boles), or by the accidental felling of occupied snags, or damaged or hollow trees during timber harvest or other activities; and (b) a short-term reduction in the total amount of foraging habitat available to individual Indiana bats which would be incurred on regeneration cuts. Although these bats will use small forest openings and edges as foraging habitat, they would be unlikely to utilize the central portions of harvested units during the early years of regeneration unless the residual basal area was high enough. It is possible that the increased rate of insect production in the regeneration areas would make up for any loss of foraging habitat acreage, but such a determination would be difficult to make without extensive long-term research on the subject. The level of estimated timber harvest ranges from 1,000 to 5,000 acres depending on Alternative. Specific acreage by type of silvicultural system for each alternative is discussed in the Social/Economic Environment, Timber Management section of the EIS. See specifically Table 3C6-14.

Although the likelihood is very low, implementation of any alternative may result in the inadvertent loss of individual Indiana bats or small groups of Indiana bats, via removal of some large-diameter hardwood trees occupied by bats during the period April 1 through October 15. This risk would be greatest in those alternatives

with the highest acres of timber harvest. Alternative D has the highest acres estimated, followed by Alternatives A, B, E, G, H and I, and F in order. Alternative C has no timber harvest allowed.

Under all alternatives, Forestwide and management prescription standards will provide adequate protection for summering and transitory Indiana bats. These standards and prescriptions provide for maintenance of extensive forest areas that would remain undisturbed. These areas are characterized by disturbance events where net losses and gains of potential roost trees would be dependent on ecological processes including tree mortality due to aging, insect and disease, wildland fires, and weather events.

In addition, all alternatives allocate areas surrounding known Indiana bat hibernacula to Management Prescription 8E4a and 8E4b. In the future, any newly discovered hibernacula will be added to this prescription through the Forest Plan amendment process. In the 1997 Biological Opinion for the Forest, and the 2004 BO for the Jefferson NF, the USDI Fish and Wildlife Service determined that the level of anticipated take (4,500 acres not including prescribed burning on the Forest and 16,800 acres including prescribed burning on the JNF) is not likely to result in jeopardy to the Indiana bat or destruction or adverse modification of any critical habitat. Although the loss of a few individuals from time to time during timber harvest is remotely possible, the overall large amount of improvement of roosting and foraging habitat for the Indiana bat, coupled with management activities taking bat life requirements into account, plus an increasing number of upland drinking water sources, and gating of hibernacula, suggests that these potential losses would be offset by overall future net gains in the population.

Long-term effects of WNS are unknown at this time. It’s likely that Indiana bats will be further affected by WNS and those cumulative effects may exceed any action Forest Plan implementation will cause.

Cumulative effects of wind power development will be addressed in project level analysis if and when the Forest receives a proposal for construction.

Virginia Big-Eared Bat

AFFECTED ENVIRONMENT

Formerly included in the genus *Plecotus*, the Virginia big-eared bat is a subspecies of the more common and widespread Western (or Townsend’s) big-eared bat that occurs throughout the western U.S., southwest Canada, and most of Mexico. The subspecies, *virginianus*, occupies a very limited geographic range in the Central Appalachians that includes portions of four states: West Virginia, Virginia, Kentucky, and North Carolina (Bayless et al. 2011). The species was listed under provisions of the Endangered Species Act as “Endangered” in December 1979. The Recovery Plan was issued on May 8, 1984 and a draft revised recovery plan was submitted for review in 1996, but was never finalized. The first substantive 5-year review of the species was released by the USFWS, West Virginia Field Office, during the summer of 2008. On March 6, 2012, a request was made in the Federal Register by the USFWS for information to initiate a 5-year review of 9 listed species in the northeast, including the Virginia big-eared bat.

Population numbers have shown moderate to strong increases range-wide over the past 20 years. In the late 1970s, when the recovery plan was drafted, the known population of Virginia big-eared bats in maternity colonies was approximately 3,600, and the known hibernating population was approximately 2,585 (U.S. Fish and Wildlife Service 2008). In the late 1980s, the estimated, total population of the subspecies in West Virginia, Virginia, Kentucky, and North Carolina was approximately 10,000 bats (Dalton 1987). By 1997 the range-wide population of *C.t. virginianus* was estimated to have almost doubled to just under 20,000 individuals (Pupek 1997). In West Virginia some cave populations grew as much as 350% from 1983 to 1995 (Pupek 1997). Survey data from 2006-2007 indicate a population of 11,694 hibernating bats and 7,630 maternity colony bats (USFWS 2008). These surveys did not include bachelor colonies or several caves with significant bat use due to access or safety concerns. The 2012 surveys of the 10 summer colonies in West Virginia show that the Virginia big-eared bats continue to do well with the total being the highest count on record with 7,531 bats, up 0.9% from 2011 and up 18.2% since 2008, pre-WNS (WNS was found in WV in 2009). The 2012 count increased in 8 of the 10 caves compared to the 2011 count (Stihler 2012 per comm).

In Virginia, this bat is known from eight caves in six counties in two separate geographic areas. One area is in the upper headwaters of the James River (Cowpasture and Bullpasture Rivers) and the other is in the New River watershed. According to the Virginia Fish and Wildlife Information Service, the Virginia big-eared bat is known from three caves in Tazewell County and one in Highland County during the summer and five caves during the winter in Tazewell, Bland, and Highland Counties. Previous observations of single or a few (<5) individuals in caves found in Rockingham, Bath, and Pulaski Counties are likely transient males and are only seen occasionally in these locations.

In West Virginia, the Virginia big-eared bat is known from at least 30 caves in five counties, with most of the occurrences (20) in Pendleton County. The final rule that placed the Virginia big-eared bat on the endangered species list also designated five caves in West Virginia as Critical Habitat: one cave in Tucker County (Cave Hollow Cave) and four caves in Pendleton County (Cave Mountain Cave, Hellhole Cave, Hoffman School Cave, and Sinnit Cave).

The Virginia big-eared bat occupies caves year-round. These bats are not migratory and their longest recorded movement is approximately 64 kilometers (40 miles; Dalton & Handley 1991). Males and females hibernate singly or in mixed gender, single species clusters in a few caves, and move in the spring to other cave(s), with females forming smaller summer maternity/nursery colonies and males remaining solitary, or forming bachelor groups, during the summer.

Mating begins in late summer/early autumn and continues into early winter. Ovulation and fertilization are delayed until late winter/early spring. Maternity colonies form as early as March or as late as June depending on when the roost site reaches a suitably warm temperature. Gestation lasts 2-3.5 months. Solitary pups are born in late spring/early summer. Young can fly at about 2.5-3 weeks of age, are weaned by 6-8 weeks, and leave the cave to forage on their own by the end of July or August. Most individuals leave the nursery cave by mid to late September. Females are sexually mature their first summer. Males may not be sexually active until their second year. Nearly all adult females breed every year (NatureServe 2011).

The Virginia big-eared bat primarily feeds on moths. Morphological adaptations (long ears and wing shape that results in low wing loadings) facilitate foraging tactics which involve slow-maneuverable flight where prey can be captured in air or from the surface of objects. Foraging techniques consist both of aerial hawking and gleaning. Lacki and Dodd (2011) noted that Lepidopteran prey comprises >80% volume of the diet of all *Corynorhinus* species. Food habits of the maternity colony in Tazewell County, Virginia found that moths formed over 90% of the diet, with beetles a distant second, followed by lesser quantities of other flying insects. The bats typically leave the cave after sunset with the onset of full darkness to begin foraging. Level of flight activity in Virginia big-eared bats is negatively associated with moon phase and wind speed, and directly related to percent relative humidity (Adam et al. 1994). Foraging area averages approximately 280 acres (60–650 acres). Maximum flight distance of foraging from caves is 7.0 miles, with 80% of foraging occurring within 3.7 miles (Stihler 2010). Bats have been observed foraging over corn and alfalfa fields as well as mature upland forests, wherever moths occur in abundance (Dalton et al. 1986). An overriding pattern of habit usage in foraging is a preference for abrupt changes in vertical structure, such as along forested and riparian corridors and forest/edge interfaces. The vertical surfaces likely help in capturing stationary moth prey by gleaning. Because most of these same habitats are avoided by families of moths typically eaten by *Corynorhinus*, Lacki and Dodd suggest that foraging habitats are better predicted by structural configuration than by local abundance of preferred moth prey (Lacki and Dodd 2011).

Limiting factors for the Virginia big-eared bat include caves with suitable temperature regimes (cold in winter and warm in summer). Compared to other bats, Virginia big-eared bats tolerate lower cave temperatures during hibernation, and often occupy areas in caves that receive cold-air flow near entrances. Maternity caves are typically warmer than hibernation caves. Declines appear to be primarily related to human disturbance and loss of cave habitat quality. The Virginia big-eared bat is extremely intolerant of any human disturbance. Former declines in bat populations are likely attributable to human intrusion into caves, which depletes energy reserves of aroused bats and may lead to cave abandonment if disturbance is frequent (NatureServe 2011). The recovery plan (USDI Fish and Wildlife Service 1984) recommends recovery actions focused on cave acquisition and gating of entrances to control human access. The increased population of Virginia big-eared

bats over the past 30 years is likely attributable to gating and year-round closure of caves occupied by these bats.

On the Forest there are no caves regularly occupied by the Virginia big-eared bat at any time of the year. All occupied caves in Virginia, during both summer and winter, are on private land. Cave occurrences of the Virginia big-eared bat closest to the Forest are located in Highland County, Virginia, and Pendleton County, West Virginia, where the closest distance from an occupied cave to Forest managed land is approximately 2.5-miles (Arbegast Cave, Highland County). In Pendleton County the closest distance from caves designated as Critical Habitat to Forest land is: Hellhole Cave, 12.6 miles; Cave Mountain Cave, 10.25 miles; Sinnit Cave, 5.0 miles; and Hoffman School Cave, 3.6 miles. It's therefore possible, based on observed flight distances for foraging activity of 2.2–5.2 miles, that Virginia big-eared bats may forage over some portions of the North River Ranger District, from the Brandywine area of Pendleton County, WV south to the McDowell area of Highland County, VA.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The greatest threat currently known to Virginia big-eared bats is human disturbance in hibernacula, roosting, and maternity caves. None of these caves occur on the Forest. The Forest has assisted with building and maintaining cave gates, such as the purchase of materials and construction of the gate on Arbegast Cave in 2007. Currently, all the caves on or near the Forest utilized by the endangered Indiana bats are gated and locked year-round, plus a Closure Order, issued by the Regional Forester to lessen spread of WNS and prevent disturbance to bats, continues on all caves and mines.

Negative effects to Virginia big-eared bats from vegetation management are minimal because these bats utilize caves year-round for all roosting and hibernation. Vegetation management such as timber harvest, thinning, and prescribed burning will increase vertical structure in closed canopy forests creating a spatial mosaic of conditions and will therefore provide and enhance foraging habitat.

Under all alternatives, Forest Plan standards relevant to the Virginia big-eared bat and associated cave habitat would protect all caves now known on the Forest, as well as any cave discovered or purchased that may support Virginia big-eared bats. Although no hibernacula, summer roost, or maternity caves have been identified on the Forest, forestwide standards maintain vegetation, and require installation of gates or other protective structures, at entrances of all caves occupied by populations of any threatened or endangered bats. Until a newly discovered cave has been surveyed for bats, it is assumed that federally listed bats are present and the cave and surrounding habitat are maintained for them until surveyed. Potential foraging habitat will be maintained in a mosaic of vegetative conditions, and any changes will result from forest succession and management activities such as timber sales and prescribed burning.

Recent potential and known threats include White Nose Syndrome (WNS) and commercial-scale wind power development.

WNS is a fungus caused disease that was first seen in New York caves during the winter of 2006-2007. The newly discovered, cold-loving fungus (*Geomyces destructans*) has spread south during the past several years and was first confirmed in Virginia and West Virginia during the winter of 2008-2009. Since 2009, the fungus has continued to spread and contaminate caves in and near the Forest. To date, there have been no Virginia big-eared bats found with WNS (Stihler 2012 pers. comm.). WNS has been documented in caves occupied by Virginia big-eared bats, yet the bats do not show signs of infection, and no mortality attributable to WNS has been documented.

All caves with significant bat populations on Forest land will continue to be gated and locked. Currently, a Regional Forester closure order is in effect that closes all caves and mines on the National Forest to human intrusion. If and when access is needed to any cave, WNS protocols will be followed that are designed to reduce the potential for contamination from caving activity.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County.

Bats are often killed by wind towers when they fly into the lower pressure surrounding the trailing edge of spinning blades, and suffer extreme barotrauma because the decompression causes capillaries in their lungs to explode. Bats are most affected during periods of fall migration because they often follow ridgetops and come into contact with wind towers built along those same ridgetops.

Alternatives C, and E do not allow for commercial wind power development. Alternatives B, D, F, G, H and I allow for consideration of wind power development. Alternatives B, F, G, H and I assume one development site and assume 15 towers per site, while Alternative D assumes three sites and assumes 45 towers. Currently there are no proposals for wind power development on the GWNF. Any such proposal will be evaluated with an environmental analysis and impacts to bats will be disclosed at that time.

There are expected to be no cumulative effects to the Virginia big-eared bat resulting from implementation of any alternative. As stated above, the caves where this species occurs are on private land near the Forest. Landowners of these caves are aware of the bats' presence and the caves are either gated or protected to limit human entrance and disturbance. Individual Virginia big-eared bats may forage or fly over National Forest land, but current conditions will be maintained, and habitat enhanced through active management for preferred foraging habitat in all alternatives except Alternative C. Active management will include timber harvest, thinning, and prescribed burning will designed to increase forest openings and decrease canopy closure.

There have been concerns about the effect gypsy moth (*Lymantria dispar*) defoliation and suppression efforts may have on Virginia big-eared bats. Gypsy moths are well established across the Forest. Defoliation, and the subsequent short-term loss of forest cover, may suppress insect populations and thus food sources for the bats. Likewise, pesticides suppress or eliminate insect populations to varying degrees, depending on the type of insecticide used (USDA 1996). Suppression of gypsy moth outbreaks have not been done on the Forest since Spring of 2003 when 1,311 acres in six areas were treated with Btk and none of those areas were within 50-miles of known Virginia big-eared bat occurrences. If necessary in the future decisions on gypsy moth management will be made at that time and further analysis handled at the project level including consultation with the US Fish and Wildlife Service.

Effects of WNS are unknown at this time. If infection occurs in Virginia big-eared bats and they are negatively affected by WNS there is little if anything the Forest can do other than assist with surveys and monitoring, plus keep caves gated and closed on a year-round basis.

Direct and cumulative effects of wind power development will be addressed in project level analysis, including consultation, if and when the Forest receives a proposal for construction.

Virginia Northern Flying Squirrel

AFFECTED ENVIRONMENT

Overview and Biology

The Virginia northern flying squirrel (*Glaucomys sabrinus fuscus*; hereafter abbreviated VNFS) is a nocturnal small mammal endemic to the Alleghany Highlands of West Virginia and Virginia. The species was federally listed as Endangered in 1985, along with another subspecies, the Carolina northern flying squirrel (*Glaucomys sabrinus coloratus*), and is also state listed as endangered under the Virginia Endangered Species Act (Fies and Pagels 1991). VNFS is a relatively short-lived species primarily inhabiting mature spruce forest, as well as the ecotone between spruce and northern hardwood forests (Ford et al. 2004; Ford and Rodrigue 2007; Loeb et al. 2000; Menzel et al. 2004, 2006a; Reynolds et al. 1999; Schuler et al. 2002; Smith 2007; USFWS 1990, 2001, 2006, 2008; Weigl et al. 1999). VNFS will eat a range of seeds, buds, fruits, and insects, but, in the Appalachians, the squirrels rely heavily on hypogeal fungi (truffles) and lichens associated with the root systems of red spruce (Ford et al. 2004; Ford and Rodrigue 2007; Loeb et al. 2000, Maser et al. 1978, 1986, Maser and Maser 1988; Mitchell et al. 2001). While nesting mainly in tree cavities in live hardwoods and snags (yellow birch and American beech are preferred), the VNFS will also utilize leaf or 'drey' nests in conifers such as red spruce and eastern hemlock, and have been observed using multiple den/nest sites in one season

(Hackett and Pagels 2003; Menzel 2003; Menzel et al. 2000, 2004; Weigl et al. 1999). Den sites have often been found in trees and snags larger and taller than surrounding tress, and near trails, old logging roads, or railroad grades (Hackett and Pagels 2004; Menzel et al. 2004). VNFS will occupy artificial nest boxes (Reynolds et al. 1999). Individual home range sizes are variable, ranging from 5 to > 100 ha in West Virginia (Urban 1988; Menzel et al. 2006b). Home range size varies by habitat structure quality and seasonal food abundance, with males tending to have larger home ranges than females (Weigl et al. 1999). Optimal habitat is red spruce forest exhibiting mature to old-growth characteristics on north and east-facing slopes, with large trees, numerous snags, high volumes of coarse wood debris, and abundant lichens and hypogeal fungi providing year-round lifecycle needs (Carey 1989, 1991, 1995; Ford et al. 2004; Hackett and Pagels 2003; Odom et al. 2001; Payne et al. 1989; Rosenburg 1990; Shuler et al. 2002; Weigl et al. 1999). However, VNFS can persist in and around remnant patches of red spruce and mixed spruce-northern hardwood forest (Ford et al. 2004; Menzel 2003; Menzel et al. 2004, 2006a, b; Smith 2007).

Habitat Availability

In a 2006 5-year review and 2008 final rule, the USFWS estimated a range of 242,000 to 600,000 acres of potential suitable habitat for VNFS, generally following the spine of the high Allegheny Plateau in a northeast to southwest alignment (Menzel et al. 2006b; USFWS 2006 and 2008). No critical habitat has been designated for this species. Based on the Menzel habitat suitability model, the majority of 'optimal' (80%) and 'likely' (65%) habitat is found on the Monongahela National Forest in West Virginia (Menzel et al. 2006b; USFWS 2006 and 2008). Approximately 6,268 acres of mixed spruce and northern hardwood habitat occurs in the Laurel Fork area on the Forest, in Highland County, Virginia. This represents approximately 3% of the total estimated habitat for the VNFS rangewide and 25% of an estimated 25,250 acres of 'likely' habitat in Highland County, Virginia, as determined by the Menzel habitat suitability model (Menzel et al. 2006a; USFWS 2006 and 2008). At Laurel Fork, mature red spruce is found mixed within northern hardwood forest types, primarily associated with riparian areas along Buck, Slabcamp, Bearwallow, and Newman Runs, all on the upper east flank of Alleghany Mountain (Fleming and Moorhead 1996). Current estimates of mature red spruce is 219 acres, with an additional 154 acres of mature red spruce in plantations on the upper slopes of Allegheny Mountain, in the vicinity of Buck Knob and Locust Spring Run (Fleming and Moorhead 1996; USFS 2011). In addition, 116 acres of mature red pine plantation is present in the same area. Most of the spruce and red pine is estimated to be 90 years or older. Adjacent to the spruce and pine plantations and intermixed along the tributaries to Laurel Fork and Laurel Fork itself are an estimated 158 acres of open beaver meadow/wetland glades, and herbaceous and shrubby old field habitat (Fleming and Moorhead 1996). In total, 373 acres of mature red spruce and an additional 116 acres of mature red pine are components of the 6,268 acre mixed spruce/northern hardwood forest complex in Laurel Fork. Abundant red spruce regeneration is present throughout the area, both in the understory of spruce/northern hardwood forests and in adjacent old beaver meadows and wetland glades, making the total acreage of the spruce forest component estimated at around 600 acres (Fleming and Moorhead 1996; USFS 2011).

Population Trends

At the time of federal listing in 1985, VNFS was known to occur in four geographic areas, three in West Virginia (Cranberry Glades, Cheat Bridge/Cheat Mountain, Stuart Knob) and one in Virginia (Laurel Fork). The USFWS has documented 109 known sites with VNFS, 107 in West Virginia, and two in Virginia (USFWS 2006 and 2008). The Virginia population is known only from Highland County, Virginia and is considered part of the Spruce Knob/Laurel Fork population cluster (Pocahontas, Randolph, Pendleton Counties, West Virginia, and Highland County, Virginia) (USFWS 2006 and 2008). A population of uncertain genetic status is also located in southwestern Virginia at Mt. Rogers National Recreation Area and adjacent Grayson Highlands State Park (USFWS 2006 and 2008). Several studies have attempted to determine whether this population is the Virginia or Carolina northern flying squirrel subspecies, or an intergrade between the two, with the most recent research indicating a likely genetically distinct population (Arbogast and Schumacher 2010; Fies and Pagels 1991; Reynolds et al. 1999; Sparks 2005). Until the genetic uncertainties are officially resolved, the USFWS recovery plan for Carolina flying squirrel includes this population for conservation and management purposes, and is addressed in the Jefferson National Forest Revised Land Management Plan (USFS 2004; USFWS 2006). Since 1985, the Laurel Fork area has been monitored for VNFS using a combination of presence/absence surveys with nest box checks and live capture/recapture methods (J. Pagels unpublished data; Reynolds et al.

1999). At the time the first Forest Plan Revision was signed (1993), monitoring efforts estimated fewer than 20 individuals in the Laurel Fork Area (USFS 2011). Despite repeated monitoring efforts for over twenty years, very few VNFS have been captured. During a 10 year mark/recapture study on two sites in Laurel Fork (1986-1996), only one squirrel was captured in 10 years on site one, and 3-6 captured in four of 10 years on site two (Reynolds et al. 1999). Despite a low capture rate throughout the years, VNFS have been shown to persist in the Laurel Fork area with the most recent capture in 2004 (J. Pagels unpublished data). Three sites in Laurel Fork on the Forest have now been documented to have VNFS, as well as two sites on private land in Highland County, one adjacent to Forest land in Laurel Fork (Rick Reynolds, VDGIF and Marek Smith, TNC, pers. comm., 2012). The USFWS acknowledges known inadequacies in current monitoring techniques for VNFS to prove or disprove presence of the VNFS (USFWS 2001, 2006, 2008). The current Recovery Plan for VNFS, as amended, encourages the assumption of presence in suitable habitat, because the squirrels are less likely to use nest boxes or enter traps in good quality habitat due to the abundance of natural den sites and preferred foods in these areas (USFWS 2001).

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

A number of natural and human-related threats have been documented for the VNFS in the USFWS recovery plan, USFWS 5-year review, USFWS Final 2008 Rule, and published research.

Loss of suitable habitat and connectivity. Historically, the Allegheny Highlands contained over 500,000 acres of old growth spruce-dominated forest in the Allegheny Highlands (USFWS 2006 and 2008). Much of this was lost through historical logging and associated wildfires, which led to the replacement forest being more dominated by northern hardwood types, with a reduced spruce/conifer component (Adams and Stephenson 1989; Schuler et al. 2002). This habitat change and resulting fragmentation of suitable habitat had a serious negative impact on the size and distribution of VNFS populations throughout their range (Ford and Rodrigue 2007; USFWS 2006 and 2008). Currently, an estimated 242,000–600,000 acres of varying suitability exists for VNFS, based on the consolidation of several habitat suitability models (USFWS 2006 and 2008). In the Laurel Fork area on the Forest, 373 acres of mature red spruce, an additional 116 acres of mature red pine, and an estimated 300 acres of red spruce regeneration are intermixed within 6,268 acres of mixed spruce/northern hardwood forest ecological system. The current Forest Plan Revision (1993) identifies this area as the Laurel Fork Special Management Area and the Laurel Fork Roadless Area (USFS 1993), and management of the area has been in compliance with the guidelines of the VNFS Recovery Plan, as amended. Alternatives A, B, D, E, G, H and I identify the Laurel Fork Area as a Special Biological Area and as Remote Backcountry. The Laurel Fork Area is also a Potential Wilderness Area. VNFS Recovery Plan Guidelines will continue to be followed in habitat with known populations or the potential to have populations of VNFS. Objectives for the Spruce Forest and Northern Hardwood Ecological Systems are to maintain current acreage. In Alternatives B, D, E, G, H and I there is also an objective to re-establish about 1,300 acres of regenerating spruce across the planning period. Where non-native red pines were planted, red spruce should be restored. Forestwide standards for the Spruce Forest Ecological System are to maintain or restore the forest type. Current spruce and northern hardwood systems in the Laurel Fork area are mature and will continue to age through the life of the proposed plan revision. Spruce regeneration is also present and will continue through mostly natural means throughout the proposed planning period, although active restoration may also occur. Habitat suitable for VNFS will continue to be available through the foreseeable future.

In Alternatives C and F the Laurel Fork area is recommended for wilderness study. Natural processes would continue in the area, but active restoration activities would not occur.

Disease. Several disease threats to the habitat of the VNFS have been documented at Laurel Fork. The hemlock woolly adelgid (*Adelges tsugae*) has caused serious death and decline of Eastern hemlock forests across the Forest (USFS 2011). Eastern hemlock was identified as a component of the spruce/northern hardwood system in Laurel Fork (Fleming and Moorhead 1996), but not a dominant overstory type in the area of Laurel Fork known to have VNFS populations. Because a predominately montane conifer component is still present, it is not anticipated that hemlock woolly adelgid would pose a serious threat to the habitat quality for VNFS, given the limited role of hemlock in flying squirrel survival (USFWS 2006 and 2008). Beech bark disease results from attack by the beech scale insect, *Cryptococcus fagisuga*; subsequent fungal infestations can either cause serious decline or mortality to mature trees (Cammermeyer 1993). Evidence of beech bark

disease is present in Laurel Fork (Fleming and Moorhead 1996), resulting in scattered mortality of mature trees, but the beech component is still present in the spruce/northern hardwood community. Scattered mortality provides potential suitable cavities for VNFS (USFWS 2006 and 2008). Due to the limited amount of beech present in Laurel Fork, beech bark disease is not considered to be a serious threat to the quality of habitat for VNFS in the life of proposed Forest Plan Revision.

Impacts from southern flying squirrel. The FWS Recovery Plan states VNFS can be threatened by competition for available den sites with the southern flying squirrel (*Glaucomys volans*) and by spread of a parasitic nematode (*Strongyloides*) from the southern to northern flying squirrel (USFWS 2001). Recently, however, the USFWS has documented that while co-occurrence of both species in areas of the VNFS range has been documented, available evidence indicates occurrence and potential severity of impacts due to sympatric existence appears limited (USFWS 2006 and 2008). One possible explanation could be the decline of available beech nuts by the spread of beech bark disease, an important food source for southern flying squirrels. With regards to parasitic infestations, research has hypothesized that the parasitic nematode (*Strongyloides*) is limited by below-freezing temperatures, such as occurs throughout the range of VNFS (Wetzel and Weigel 1994). Twenty years of capture data documenting VNFS with no signs of debilitating effects due to parasitic infestation appear to bolster this hypothesis (USFWS 2006 and 2008). Therefore, the USFWS has concluded the risk of competition with the southern flying squirrel does not threaten the continued existence of the VNFS (USFWS 2006 and 2008).

Acid precipitation and climate change. Since federal listing of VNFS, acid precipitation and climate change have been cited as factors in the decline of the spruce-fir ecosystem throughout the Appalachians. The negative effects of acid deposition on fir species have been well documented, though long-term effects to red spruce have not been as conclusive (USFWS 2006 and 2008). The long-term impacts of a rise of average high temperatures due to climate change could negatively affect the extent and quality of northern hardwood and spruce ecosystems, further reducing available habitat throughout the range of VNFS (Delcourt and Delcourt 1984).

Alternatives B, D, E, G, H and I have strategies to help mitigate, as much as possible, potential effects of habitat quality and reduction of the spruce and northern hardwood ecosystem. Objectives for the Spruce Forest and Northern Hardwood Ecological Systems are to maintain current acreage and re-establish about 1,300 acres of regenerating spruce across the planning period. Where non-native red pines were planted, red spruce should be restored. Forestwide standards for the Spruce Forest Ecological System are to maintain or restore the forest type. Current spruce and northern hardwood systems in the Laurel Fork area are mature and will continue to age through the life of the proposed planning period. Spruce regeneration is also present and will continue and be encouraged through mostly natural means throughout the proposed planning period. Habitat suitable for VNFS will continue to be available through the foreseeable future.

Alternatives C and F will rely on natural processes to dictate responses of the spruce and hardwood systems to changes in acid deposition and climate change.

Across the range of the VNFS, the Monongahela National Forest in West Virginia contains the majority of the estimated suitable 242,000 acres of suitable habitat (Menzel 2003; USFWS 2006 and 2008). The Laurel Fork area in the Forest, with an estimated 6,268 acres of suitable habitat, and representing approximately 3% of the available suitable habitat range-wide, borders the Monongahela National Forest, with two Monongahela NF Management Prescription 4.1 (Spruce and Spruce-hardwood Restoration) areas within 3 and 10 miles respectively of the Forest (USFS 2006). The Laurel Fork area is considered part of the larger Spruce Knob/Laurel Fork VNFS Recovery population cluster (Pocahontas, Randolph, Pendleton Counties, West Virginia, and Highland County, Virginia) and affords the best opportunity for connectivity of habitat and long-term population gene flow for VNFS (USFWS 2006 and 2008). In Virginia, smaller areas of spruce/northern hardwood on private land adjacent to and in the vicinity of Laurel Fork, and have known VNFS populations, are under Conservation Easement through the Virginia Nature Conservancy (Marek Smith, TNC, pers. comm. 2012). The current Forest Plan Revision (1993) identifies the Laurel Fork area as the Laurel Fork Special Management Area and the Laurel Fork Roadless Area (USFS 1993). Vegetation desired conditions and management have been performed in compliance with the guidelines of the VNFS Recovery Plan, as amended,

(USFS 1993). Current spruce and northern hardwood systems in the Laurel Fork area are mature and will continue to age through the life of the proposed plan revision.

Several studies have attempted to determine whether this population is the Virginia or Carolina northern flying squirrel subspecies, or an intergrade between the two, with the most recent research indicating a likely genetically distinct population (Arbogast and Schumacher 2010; Fies and Pagels 1991; Reynolds et al. 1999; Sparks 2005). Until the genetic uncertainties are officially resolved, the USFWS recovery plan for Carolina flying squirrel includes this population for conservation and management purposes. The Whitetop and Mount Rogers areas containing northern flying squirrel habitat (approximately 6,000 acres) have been allocated to special areas in the Jefferson National Forest Land Management Plan Revision (management prescriptions 4.K.3. and 4.K.4.) (USFS 2004). Both of these special areas are classified as unsuitable for timber management and management is primarily focused on protecting and restoring the high elevation rare communities and species that inhabit this area (including the spruce-fir and northern hardwood forest and northern flying squirrel), managing forest visitor use, maintaining the outstanding vistas and natural scenery that led to designation of this area as a National Recreation Area. Key spruce-fir and northern hardwoods restoration areas have been identified in the Jefferson NF Revised Forest Plan to provide linkages to connect suitable habitat types for northern flying squirrels.

Habitat on the Forest currently occupied by the northern flying squirrel is protected and habitat and gene flow linkages are being restored through management prescriptions on the adjacent Monongahela National Forest, as well as Conservation Easements on adjacent and nearby private land. The northern flying squirrel population of uncertain genetic status at Mount Rogers is also being protected through provisions in the Jefferson National Forest Revised Land Management Plan. These actions will provide suitable habitat, connectivity, and opportunities for gene flow over the life of the proposed planning period and into the future. Therefore the cumulative effects of the proposed George Washington Revised Forest Plan will be beneficial to the VNFS.

Shale Barren Rock Cress

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2012).

Shale barren rockcress was listed as endangered under the Endangered Species Act on August 8, 1989.

It is an endemic of shale deposits, occurring only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations generally ranging from 1300 to 2600 feet. Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. All extant occurrences are on shales of Devonian age (Ludwig pers. comm.); a single occurrence was known from the Martinsburg shale of Ordovician age, but it is no longer extant. This narrow endemic is known only from shale barren regions of Virginia and West Virginia and is one of the most restricted shale barren endemics. According to NatureServe, approximately 56 occurrences are believed extant, 34 in Virginia and 22 in West Virginia, of these, most are made up of fewer than 50 individuals; there are perhaps fewer than 4,000 plants altogether. Most occurrences are on public lands, predominantly national forests.

Recovery tasks for the Forest identified in the shale barren rockcress Recovery Plan include: Implement and evaluate the monitoring program.

The following is from the Forest's Monitoring and Evaluation Report 2004:

"In 1993 there were 17 known occurrences of shale barren rockcress on the Forest. The Forest's focus since this species was listed has been to attempt to locate additional populations and further define its range on the Forest. From 1994 to 1998 agency personnel worked cooperatively with the Virginia Division of Natural Heritage and the USFWS to inventory shale barrens on the Forest (Belden, Ludwig, and Van Alstine 1999). The Virginia Division of Natural Heritage identified 809 potential shale barrens from aerial photographs. Of these,

188 were examined for rare species. The inventory resulted in 27 new occurrences of shale barren rockcress, bringing the total known sites on the Forest (in Virginia) to 42. This number does not include two sites where shale barren rockcress was known to occur recently, but could not be found in 1994. In 2004 the West Virginia Department of Natural Resources discovered a new population of shale barren rockcress at the Little Fork North Shale Barren."

Currently on the Forest there are 26 Special Biological Areas (SBAs) in Virginia and 8 SBAs in West Virginia that support shale barren rockcress. These SBAs contain all of the known shale barren rockcress populations on the Forest. Within those sites the plants may be in more than one location. Depending on how one counts populations or subpopulations, there are about 75 occurrences of this species on the Forest. The *Arabis serotina* Recovery Task Force and the Shale Barren Protection Strategy Group devised a monitoring plan for shale barren rockcress in 1993. The plan calls for monitoring this species at several sites across its range by the WVDNR between 15 August and 5 September each year, and all other sites every five years. This protocol was followed from 1993 through 2001 in WV. In 2001, it was decided that, to limit the impact of repeatedly crossing the barrens, monitoring would be conducted biennially at the Little Fork and Brandywine shale barrens in Pendleton County, as opposed to every year. In 2011 the VDNH and the USFWS entered into an agreement to resurvey all sites on U.S. Forest Service (USFS) lands in Virginia to determine their persistence and to provide information needed to enable permanent protection measures to be taken by the USFS in cooperation with the Service.

Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Recovery tasks for the Forest identified in the shale barren rock cress Recovery Plan include: implement and evaluate the monitoring program.

Threats include:

- Construction of roads, railroads, and hiking trails has impacted occurrences in the past; several occurrences are now located adjacent to these corridors where they may be impacted by erosion or maintenance activities.
- Flood control measures are a potential threat at some locations (e.g. South Fork Valley of West Virginia) (Bartgis in litt.); one barren has already been destroyed by a stream dam (Dix 1990).
- Most extant occurrences are moderately to severely browsed by deer, which is considered by some to be a prime threat to the species (USFWS 1989); quantifying the impact of deer browsing is an area of active research (Ludwig pers. comm.).
- Moderately xeric sites may be subject to encroachment of exotic plant species such as *Centauria biebersteinii* and numerous grasses (Dix 1990). Such encroachment is a particular concern for *Arabis serotina* since it does not tolerate competition well; it is generally restricted to the more open portions shale barren communities.
- A significant threat to the insect pollinators of *A. serotina* is presented by the spraying of Dimilin and BT insecticides for gypsy moth control. Because of the open habitat, shale barren insects are maximally exposed to pesticides (Dix 1990). Dimilin is a broad-spectrum biocide that persists until leaf fall and up to a few years in the duff and would have a long-term impact of shale-barren slopes. All insect occurrences on shale barrens sprayed with Dimilin should be considered extirpated (Schweitzer in litt). BT is lepidopteran-specific and only persists for roughly one week (Dix 1990). Application during larval development may have devastating impacts on the fauna.
- Finally, the very small number of individuals within many occurrences suggests that the long-term persistence of these occurrences is uncertain, especially considering that populations tend to fluctuate dramatically.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (Dix 1990). These barrens support sparse, scrubby growth; frequently-observed species include *Quercus ilicifolia, Q. prinus, Q. rubra, Pinus virginiana, Juniperus virginiana, Prunus alleghaniensis, Rhus aromatica, Celtis tenuifolia, Kalmia latifolia, Bouteloua curtipendula, Andropogon scoparius, Phlox subulata var. brittonii, Silene caroliniana ssp. pensylvanica, Sedum telephoides, Antennaria spp., Aster spp*., and *Solidago spp.* (Dix 1990). Local variations in associated flora may be considerable (Braunschweig et al. 1999; Jarrett et al. 1996; Keener 1970; Keener 1983; Wieboldt 1987).

Although adequate moisture is available for most plants within the substrata of the shale layers, adverse surface conditions act to restrict germination and establishment success of plants (Platt 1951). It is primarily the effect of high surface temperatures that limits plant reproductive success in these habitats. Surface soil temperatures are often well above the physiological tolerance of most plant species, reaching maximum temperatures of 63 degrees Celsius (Dix 1990). Such temperatures are high enough to cause direct damage to seedlings. For additional detailed information pertaining to the shale-barren community, see Dix (1990).

Because of the highly stressful nature of shale barren environments, this species is not believed to be capable of tolerating much additional disturbance. Specific threats (NatureServe 2012) include:

1) Construction of roads, railroads, and hiking trails has impacted occurrences in the past; several occurrences are now located adjacent to these corridors where they may be impacted by erosion or maintenance activities.
2) Flood control measures are a potential threat at some locations (e.g. South Fork Valley of West Virginia) (Bartgis in litt.); one barren has already been destroyed by a stream dam (Dix 1990).
3) Most extant occurrences are moderately to severely browsed by deer, which is considered by some to be a prime threat to the species (USFWS 1989); quantifying the impact of deer browsing is an area of active research (Ludwig pers. comm. and WVDNR 2011).
4) Moderately xeric sites may be subject to encroachment of exotic plant species such as *Centauria maculata* and numerous grasses (Dix 1990). Such encroachment is a particular concern for *Arabis serotina* since it does not tolerate competition well; it is generally restricted to the more open portions shale barren communities.
5) A significant threat to the insect pollinators of *A. serotina* is presented by the spraying of Dimilin and BT insecticides for gypsy moth control. Because of the open habitat, shale barren insects are maximally exposed to pesticides (Dix 1990). Dimilin is a broad-spectrum biocide that persists until leaf fall and up to a few years in the duff and would have a long-term impact of shale-barren slopes. All insect occurrences on shale-barrens sprayed with Dimilin should be considered extirpated (Schweitzer in litt). BT is lepidopteran-specific and only persists for roughly one week (Dix 1990). Application during larval development may have devastating impacts on the lepidopteran fauna.
6) The very small number of individuals within many occurrences suggests that the long-term persistence of these occurrences is uncertain, especially considering that populations tend to fluctuate dramatically.
7) Fire suppression is a potential threat. In his draft report on the classification of West Virginia shale barrens, Vanderhorst (in Norris and Sullivan 2002) states:

   "A potential threat to shale barrens is succession, or woody encroachment. Although shale barrens are usually thought to be edaphicly [sic] maintained, it is possible that disturbance such as fire may have some role in maintaining the open physiognomy necessary for survival of shale barren endemics. Fire may be a factor in some shale barren community types and not in others. It is possible that the high cover by deciduous woody species in plots of this community type is due to fire suppression and that the quality of these barrens is declining. Fire is thought to have played a historical role in maintenance of white pine-mixed oak communities near shale barrens on the Greenbrier District of the Monongahela National Forest and in the absence of fire these communities appear to be succeeding towards dominance by more mesophytic species (Abrams et al. 1995). Research into the historical role of fire in maintaining shale barrens is needed to determine appropriate management of this rare community."

FIRE

The specific role of fire in relation to shale barren rockcress is uncertain. No in-depth studies have been conducted about the direct or indirect effects of fire on this species; however, an increasing number of studies are showing the historical importance of fire in the Central Appalachians in shaping vegetation communities. Shale barren rockcress habitat is on extremely xeric south to southwest facing slopes in oak forests that are prone to wildfire. It would seem logical that fire would periodically burn through forest communities containing shale barren habitat and there is an increasing body of research that shows, until the early 1900s when fire suppression became universal, that fires occurred regularly on the Central Appalachian landscape. Abrams and others (1995) studied a forest that is transitional between the Ridge and Valley and Appalachian Plateau in Greenbrier County, WV. They concluded that without active management, including the use of prescribed fire, the present white pine-oak forest would transition to a more mesic maple-beech-hemlock forest. Lafon (2010) discusses the role of fire in table mountain pine-pitch pine stands. These pine types are found on dry ridgetops and south to west facing slopes often similar to areas supporting shale barrens. Dendroecological work shows these stands burned frequently in the past, with a regime of frequent surface fires at intervals of 2 to 10 years, and more severe burns at 50 to 100 years intervals. The surface fires maintained open understories needed by shade intolerant herbs and small shrubs. The more severe burns exposed mineral soil and created large canopy gaps enabling shade intolerant pine seedlings to become established. Lafon goes on to discuss the 'fire-oak' hypothesis which posits that many oak forests developed during many centuries of frequent burning. Fire benefits oaks by inhibiting fire sensitive tree species, which do not have oaks' protective bark, ability to compartmentalize fire damaged wood to prevent decay spread, extensive root systems, and strong sprouting ability. Aldrich and others (2010) studied fire chronology from 1704 to 2003 of trees on Mill Mountain in Bath County, VA on the Forest in an area where at least 10 *Arabis serotina* populations occur within 3.5 miles. They found a local fire return interval of about 5 years from the early 1700's until 1930 when fire suppression began. They also found that area-wide fires affecting multiple pine stands were common, recurring approximately every 16 years. The fires were frequent surface fires with occasional severe ones. In the Rough Mountain Wilderness, on the National Forest near the Mill Mountain study site, there were two lightning caused wildfires in 1999 alone (S. Croy pers. comm.). Aldrich and others (2010) conclude that "The greatest impact of industrial society is fire exclusion, which permitted hardwood establishment." There has been a trend since the initiation of widespread fire suppression of pine stands being overtaken by hardwoods in general, and of oak species being replaced by fire intolerant species such as red maple, white pine, tulip poplar, beech, and black gum (Groninger et al. 2005; Harrod and White 1999; Lafon and Grissino-Mayer 2005; Schuler and McLain 2003). It is possible that prescribed burning can halt and perhaps reverse this "mesophication" (Nowacki and Abrams 2008) of the forest.

Most shale barrens have little to no fuel loading so fire intensity, if any, would be expected to be low on the barren itself. Platt (1951) states fires are not a causal agent in shale barren formation. He goes on to say that "Fires in this region are quite rare and localized. Since shale barrens surfaces are bare and tree cover sparse, they usually escape even those fires which completely surround them. Careful examination of tree trunks gave no indication of fire scars." It could well be that Platt's observations are the result of the vigorous program of fire suppression. His comments about the fate of shale barrens in the event of fire are important. The lack of fuel loading would make fire spread nearly impossible in the shale barren environment. However, periodic fire might open and maintain habitat adjacent to the shale barren allowing shale barren rockcress populations to persist or expand. The LANDFIRE Biophysical Setting Model for Appalachian Shale Barrens states that "The absence or sparseness of fuel makes fire relatively unimportant on the barrens themselves, but is likely important in maintaining the adjacent pine and pine-oak dominated woodlands and limiting their encroachment along the barren-woodland edge. Likewise the "shale ridge bald" is maintained by edaphic conditions, but fire is likely important in limiting tree and shrub encroachment" (Croy and Smith 2009). Jarrett and others (1996) conducted an ecological study of shale barren rockcress on property managed by the U.S. Navy in West Virginia. In comparing their vegetation data with data collected ten years earlier they note that "(tree) canopies have closed somewhat at various West Virginia shale barrens, and that some shale barren endemics are no longer there." They go on to suggest that controlled burning or periodic thinning of the canopy may be necessary to set back plant succession (see discussion of mesophication above). This view is echoed by the West Virginia Department of Natural Resources factsheet on shale barren rockcress (accessed online in 2012), "Some observations suggests [sic] that some shale barrens may not always remain barren and dry. Over time, it is possible for conditions there to change, and more trees may eventually grow on them. If more

trees grow there, shale barren rockcress may not be able to survive." Several prescribed burns on the Forest in the past included shale barren rockcress habitat and plants.

Fire that burns immediately adjacent to shale barren rockcress plants might have a negative effect depending on the fire's intensity and duration. The higher the intensity and the longer the duration of fire exposure, the greater the effect and an individual plant may be killed. Fire may also have a beneficial effect as noted above. In the past, fire was considered to not be an important factor on shale barrens, especially if they are larger (larger buffer of the interior from fire) and/or steeper (less fuel build up on steep slopes). Since shale barren rockcress plants are usually more abundant in the more open parts of shale barrens, plants growing on smaller shale barrens would be more susceptible to encroachment by woody plants in the absence of fire, although all barrens could be affected to some extent. In addition to potentially enhancing seed germination, plant growth, and flowering and fruiting, fire could open the canopy on the periphery of shale barrens benefitting shale barren rockcress plants. Frequent low intensity fires would have a protective effect by lessening fuel loading in the vicinity of shale barrens and reducing fire intensity and duration. Observations have also shown that deer browse is lessened on rockcress plants when the areas around shale barrens have been burned. This is likely due to increased browse available as the result of coppice growth from top-killed trees and shrubs. This effect lasts for several years as coppicing continues and berry and nut production increases.

There are possible threats to shale barren communities from invasive native and exotic species, deer browsing, and mesophication.

All known locations of shale barren rock cress on the Forest in WV and VA are on land allocated to management prescription 4D, Special Biological Area. Habitat for this species is stable on the Forest. There are possible threats to shale barren communities from invasive native and exotic species. Populations appear stable, but since they naturally tend to fluctuate greatly from year to year, this is uncertain. Potential habitat is being inventoried and continues to reveal new populations that will be protected. Management activities are having no effect on the habitat that contains the shale barren rock cress and thus are having no effect on the rock cress.

Overall, viability is being maintained through identification and protection of occurrences, however, viability is still of concern due to the naturally limited distribution of this species. Shale barren rock cress populations are expected to remain relatively stable in the near future.

The Forest encompasses several populations of the endemic shale barren rock cress that are in the core of its limited distribution in the Northern Ridge and Valley Section of the mid-Appalachians. This species is inherently rare and not well distributed across the Forest. Current management provides for ecological conditions capable to maintain the shale barren rock cress populations considering its limited distribution and abundance. Overall, ecological conditions are sufficient on the Forest to maintain viability (persistence over time) of populations on national forest land.

Smooth Cone Flower

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Smooth coneflower was listed as endangered under the Endangered Species Act on September 8, 1992. This species is known from about 100 occurrences, a majority of which are of fair to poor viability in several southeastern states. Most historically known populations were destroyed by development and habitat alteration, especially the suppression of fire, and a number of remaining populations are primarily in marginal locations, where they are vulnerable to urbanization, the use of herbicides, repeated mowing, and potentially, collection for the medicinal trade. Small remote populations may suffer from loss of habitat due to succession.

The Recovery Plan for smooth coneflower does not have any recovery tasks specific to the Forest.

Formerly a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires as well as large herbivores (such as bison), it now primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. It is usually found in areas with magnesium and calcium-rich soils and requires full or partial sun. Associated species include: *Juniperus virginiana* and *Eryngium yuccifolium*. Fire or some other suitable form of disturbance, such as well-timed mowing or the careful clearing of trees, is essential to maintaining the glade remnants upon which this species depends. Without such periodic disturbance, the habitat is overtaken by shrubs and trees [Endangered Spp. Tech. Bull. 17(1-2): 9-10].

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Habitat loss and degradation due to habitat alteration affected 19 of 21 populations known in 1992 (USFWS 1992). Conversion of habitat to agriculture and/or silviculture, residential and industrial development, and highway maintenance (e.g., herbicides) has threatened this species in the past and may continue. Habitat loss and degradation as a result of prolonged fire suppression is also considered a major threat to the species' habitat. Commercial digging was not thought to be a problem as this practice is generally confined to Echinacea populations west of the Mississippi River. However, the Southern Appalachian Species Viability Project (2002) reported that this showy species with medicinal uses is occasionally harvested. Remaining populations appear to be small in numbers which may result in low genetic diversity.

All known locations of smooth coneflower on the Forest are on lands allocated to management prescription 4D, Special Biological Area. There are currently two known populations of this species on the Forest. Both are in Alleghany County. One is a roadside occurrence that continues to be difficult to manage due to the steepness of the site and encroaching woody vegetation. This population is very small and may not be viable over the long-term. The second population is more robust and occurs in an open woodland area. The site needs prescribed fire to maintain the open conditions this species requires.

Virginia Sneezeweed

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Virginia sneezeweed was listed as threatened under the Endangered Species Act on November 3, 1998.

A limited amount of habitat in two Virginia counties and six Missouri counties make up this species' entire global range. There are currently 61 documented occurrences, although 4 or fewer may not be extant, with the majority in Missouri as of 2006. The Virginia occurrences were located during extensive survey work from 1985 to 1995 in over 100 limestone sinkhole ponds along the western edge of the Blue Ridge Mountains, in the Shenandoah Valley of Virginia (USFWS 1998). The Virginia occurrences are restricted to small, discrete areas around sinkholes, and occupying, in total, less than 20 acres (8 ha). Missouri occurrences occupy ca. 11 acres within both discrete and less discrete wetland habitat. Seven Virginia occurrences are currently protected by being on National Forest land. Only 9 Missouri occurrences have some protection although it is not complete. Sites in both states are threatened by drainage and residential development.

The number of Virginia documented occurrences has been revised downward to 17 by using a 1 km separation distance between occurrences (J. Townsend, VA Dept. of Conservation and Recreation 2006 pers. comm.) These 17 occurrences had previously been recognized as 30 occurrences, with an occurrence at that time being equal to the plants within a discrete pond or wet meadow. It is expected that additional survey work will find more occurrences; some of these may be within the more disturbed farm pond type of habitat. In fact, a new, small population was found on the Forest in 2009 by VDNH cooperators (C. Ludwig pers. comm.). Based on what was known at the time the draft Recovery Plan was written in 2000 there were 4 sites where plants had not been seen over several years of surveys (U.S. Fish and Wildlife Service 2000).

The Draft Recovery Plan includes the Forest in the following recovery tasks:

- Seek permanent protection for known populations.
- Identify essential habitat.
- Identify sinkhole habitat adjacent to the National Forest lands, but within the proclamation boundary, to target for future acquisitions by the GWJNF.
- Conduct studies to characterize environmental parameters of the sinkhole ponds.
- Conduct studies to characterize the hydrologic regime at selected sinkhole ponds.
- Alleviate site specific threats as the need and opportunity arise.
- Develop a monitoring plan including standard monitoring methodologies.
- Implement the monitoring plan.
- Conduct surveys for additional populations in Virginia.
- Develop guidelines as to what constitutes a self-sustaining population.
- Maintain seed sources for the species.

On the Forest all known populations of Virginia sneezeweed are located in Augusta County except for a very small population that was located in 2009 between Glasgow and Buena Vista in Rockbridge County.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.).

Exotic organisms may pose threats to *H. virginicum* populations in the near future. Purple loosestrife, *Lythrum salicaria*, is slowly spreading through Virginia and may eventually invade some *H. virginicum* sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, *Lymantria dispar*, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact *H. virginicum* populations. For example, as *H. virginicum* is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow *H. virginicum* to expand into areas from which it was formerly excluded.

The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000):

> The most serious threat to *H. virginicum* appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported *H. virginicum* and so loss of some habitat has occurred. In contrast, actions have been taken at some of the Virginia sites to stop or lessen the periodic inundation. Significant ditches have been dug at two sites, with smaller ditching at three sites. Ditching and plowing occurred at one site in the past, and some evidence of the ditch remains, but does not significantly affect the hydrologic regime. Portions of the sites at 2 sites have been filled in. It is safe to assume that the pressure to control seasonal flooding will only increase, as the area of the Shenandoah Valley where the Virginia populations of *H. virginicum* are found is experiencing rapid growth, particularly in the building and expansion of residential subdivisions.

In addition to obvious hydrological alterations made directly to the sinkhole ponds, off-site actions may affect the hydrology of the ponds. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. Little is known about the relative importance of groundwater vs. surface flow to the hydrological regime of the sinkhole ponds, but preliminary research suggests that the relative importance of these water sources is unique for each pond (E. Knapp, Washington and Lee University pers. comm.).

A variety of site-specific threats to *H. virginicum* from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. The Virginia Department of Conservation and Recreation's Division of Natural Heritage reviewed the proposal for this project in 1991 and recommended against any road widening to the east in the area of the pond and further recommended that VDOT consult with the U.S. Fish and Wildlife Service before any construction began. While the long range plans still include widening Rt. 340 to 4 lanes in this section, this project is not active; VDOT will coordinate with USFWS whenever the project becomes active (S. Stannard, VDOT pers. comm.)

Another *H. virginicum* population is near the site of silos built in the early 1990s that are used to store septic waste. This waste is eventually dumped on the ground elsewhere on this landowners' ridge-top property and not near the *H. virginicum* site. However, in a 1995 site visit by DCR-DNH a large pile of soil was present on the north side of the shallow basin that supports the *H. virginicum* population. The landowner was considering pushing the soil into the seasonally wet basin to level it out, but was agreeable to not do that. In a 1997 site visit the pile was still present and was larger than in 1995. In 1995 and 1997, it was noted that sediment from the pile had washed into the edge of the pond site, creating different soil conditions in that area and making it more favorable for weedy species (DCR-DNH database).

Mowing occurs in at least 3 of the Virginia sites. Continued mowing may provide beneficial effects to the species; a site that is one of the largest if not the largest and densest population, has been periodically mowed and bush-hogged by the landowner for an extended period of time. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted.

Herbivory does not appear to be a problem; however, the threat to *H. virginicum* from cattle grazing needs evaluation. Large populations of *H. virginicum* co-exist in three sites with cattle grazing. This suggests that the species may respond favorably to limited amounts of disturbance. Knox and others (1999) tested the hypothesis that H. virginicum is unpalatable to generalist herbivores in a common garden study; none of the H. virginicum plants were grazed by either vertebrate or invertebrate herbivores. Knox notes that this is consistent with reports of toxicity in other *Helenium* species associated with the presence of sesquiterpene lactones (Hesker 1982; Anderson et al. 1983; Anderson et al. 1986; Arnason et al. 1987). *Helenium virginicum* has been shown to contain a sesquiterpene lactone, virginolide (Herz and Santhanam 1967). According to J.S. Knox (pers. comm.), the leaves of *H. virginicum* are bitter-tasting; selective grazing by cattle of more palatable associated species therefore may eliminate plant competitors. However, other effects on *H. virginicum* from cattle grazing such as the increased nutrient loads, soil compaction, and trampling of plants are unknown. As the soils of the *H. virginicum* sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species.

With federally listed wetland species, the federal permitting process carried out by the US Army Corps of Engineers (USACOE) under authority of the Clean Water Act of 1977, is often the point at which proposed actions can be reviewed in light of their effect on a federally listed species and protection actions can be recommended. The isolated and often small seasonally wet habitat of *Helenium virginicum*, however, does not currently have direct federal protection. United States vs. Wilson 133 F. 3d 251(4th Cir. 1997) ruled that the USACOE has no jurisdiction over isolated water bodies that have no surface connection with any tributary stream that flows into traditional navigable waters or interstate waters. Nationwide Permit 26, under federal wetlands regulations (56 CFR 59134-59147, Part 330-Nationwide Permit Program), which has applied to headwater areas and isolated wetlands, is currently being revised including a lower minimum acreage (1/10 acre); the Norfolk District of the USACOE is proposing a regional minimum threshold of 1/4 acre (E. Gilinsky, DEQ, pers. comm.). These lower minimum acreages, however, will not apply to the *Helenium virginicum* habitat if the ruling in U.S. vs. Wilson stands.

Currently, so-called Tulloch ditching, draining by ditching in which excavation occurs by mechanical means that do not require placing excavated material into a wetland and in which the material is lifted and hauled to an upland disposal site, does not require that USACOE be notified or a permit obtained. Major ditching has been

used at three of the *H. virginicum* sites to control the seasonal flooding with more minor ditching used at another three sites.

As most of the populations of *H. virginicum* are on private lands, the current legal protections in place for this species will not be adequate to insure the long-term survival of *H. virginicum*. The effects of future regulation changes are not known.

Extremes in the fluctuating hydroperiod of the sinkhole ponds could, when preceded by low investment in the seed bank, result in the local extinction of populations. Extended drought at a site could make a site more favorable for colonization by other plants previously hampered by the periodic inundation of the site. This would include tree species, which could result in increased shading within the site and so reduce the areas favorable for *H. virginicum*. An extended period of inundation, coupled with development of a floating vegetation mat, such as occurred at one site (Knox 1997), could lead to local extinction if an insufficient seed bank existed to recover from the death of the vegetative plants. Either of these extremes in hydroperiod could result from normal variability in weather patterns or from larger scale climate changes, of either natural or human origin.

If found to hold true for other populations of *H. virginicum*, the self-incompatible breeding system of *H. virginicum* found in one of the populations may eventually lead to local extinction at sites with low population numbers as the chance of successful pollination decreases (Messmore and Knox 1997).

In Missouri threats include grazing and/or trampling of plants in the pasture sites and haying of the plants during the growing season. Herbicide or plant growth hormones used on roadside pose a threat to the roadside populations. All known locations of Virginia sneezeweed on the Forest are on land allocated to 4D Special Biological Area. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. There are still threats from illegal ATV use on this species.

Swamp Pink

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Swamp pink was listed as a threatened species under the Endangered Species Act on September 9, 1988. *Helonias bullata* is known from the Coastal Plain of New Jersey, Delaware, Maryland, and Virginia (formerly also Staten Island, NY, where now extirpated), as well as from higher elevations in northern New Jersey, Virginia, North Carolina, South Carolina, and Georgia. Restricted to forested wetlands that are perennially water-saturated with a low frequency of inundation, habitat specificity appears to be a critical factor in this species' rarity. Approximately 225 occurrences are believed extant, over half of which are in New Jersey; 80 additional occurrences are considered historical and 15 are extirpated. The species is locally abundant at several sites in New Jersey, Delaware, Virginia, and North Carolina; some have 10,000+ clumps of plants. In addition to sites known to have been extirpated, significant habitat has been lost throughout the range due to factors such as drainage for agriculture. A number of local population declines have also been documented in the past 20 years. Degradation of this species' sensitive habitat via changes to the hydrologic regime is the primary threat. Such changes can be direct (ditching, damming, draining) or indirect (from development in the watershed); indirect impacts are particularly difficult to address. Other threats include poor water quality, invasive species, trash, all-terrain vehicles, deer herbivory, trampling, and collection. Given this species' very specific hydrological requirements, climate change could also be an issue. *H. bullata* has limited ability to colonize new sites (low incidence of flowering, limited seed dispersal, and poor seedling establishment) and low genetic variation, limiting its ability to adapt to changing conditions and recover when sites are destroyed.

Overall trends of local population declines and extirpations are beginning to emerge (USFWS 2007). The number of occurrences considered historic has increased from 79 to 97 since 1991, a loss of 18 sites (8 in NJ, 8 in DE, and 2 in NC) (USFWS 2007). More than 20 occurrences in New Jersey and Delaware alone have

documented declines in population size or condition since the early 1990s (USFWS 2007). In New Jersey, the number of occurrences ranked A or B has decreased by 7 since 1991; comparing occurrence ranks from 1997 and 2004, 6 occurrences were upgraded while 20 were downgraded (USFWS 2007). Of the 27 occurrences discovered in Delaware between 1983 and 1999, 16 showed substantial declines in plant numbers during the most recent site visits (USFWS 2007).

Recovery tasks for Federal agencies in the swamp pink Recovery Plan include:

- Monitor threats to extant sites.
- Develop and maintain site-specific conservation plans.
- Enforce regulations protecting the species and its wetland habitat.
- Investigate population dynamics, using a standard method.
- Identify and, as needed, implement management techniques.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Habitat degradation is the primary range wide threat. This degradation is difficult to address through either land protection or regulatory mechanisms because it is often brought about by off-site land uses, particularly development. Evidence of detrimental effects of development on *H. bullata* habitat and population quality continues to accumulate; such impacts are anticipated to worsen as development continues (USFWS 2007). A major component of habitat degradation is changes to the hydrologic regime. Such changes can be direct (e.g., ditching, damming, draining) or indirect (i.e., from development in the watershed). Indirect impacts often result from increased impervious surface in the watershed, which reduces infiltration and increases overland flow of stormwater, leading to increased stream erosion, wetland sedimentation, flood volumes and velocities, water level fluctuations, and hydrologic drought (USFWS 2007). Other components of degradation associated with adjacent development include poor water quality, invasive exotic species, trash, all-terrain vehicles, herbivory by overabundant deer populations, trampling, and collection (USFWS 2007). Direct habitat losses have slowed, but historical losses were substantial (USFWS 2007). Because this species requires a very specific hydrology in order to thrive, climate change, which has the potential to either increase or decrease water levels at established sites, is an anticipated threat. For example, increased drought in southern Appalachians mountain bogs may already be having detrimental impacts. Also, about 10% of known occurrences are in areas with increased vulnerability to coastal flooding due to sea level rise (USFWS 2007).

The specific wetland habitat required by this species is easily degraded through both direct and secondary disturbances; among the wetland types it inhabits, some such as sphagnum bogs and Atlantic white cedar swamps are particularly fragile. A low incidence of flowering, limited seed dispersal, and poor seedling establishment combine to make colonization of new sites via reproduction from seed rare for this species (Godt et al. 1995; USFWS 2007). Finally, Godt and others (1995) found low overall genetic diversity both within the species and within populations, even relative to the means found for other endemic and narrowly distributed species. This suggests that *H. bullata* may have limited capacity to adapt to future environmental change.

Habitat specificity appears to be the critical factor in defining *H. bullata* as a rare species (USFWS 2007). Adapted to stable habitats with a number of specialized conditions (e.g., low light, limited nutrients, and saturated soils), this species appears to compete poorly when change in one or more habitat parameters creates an opportunity for the establishment of other species (USFWS 2007). Habitat availability may be a limiting factor across much of the range; Coastal Plain forested headwater wetlands have been significantly reduced by development, and mountain bogs are both historically uncommon and impacted by agricultural conversion (USFWS 2007). Nevertheless, the New Jersey Pine Barrens contain some apparently suitable but unoccupied sites, suggesting that this species' habitat requirements are not fully understood and/or that low dispersal limits colonization of these areas (USFWS 2007). Efforts to create or restore *H. bullata* habitat have had limited success (USFWS 2007).

All known occurrences of swamp pink are on land that will be allocated to 4D, Special Biological Area, and/or 1A Designated Wilderness. These Special Biological Areas are managed specifically to restore and maintain

conditions to benefit the community and/or rare species for which the area was established. Herbivory and shading may continue to be threats. Use of wildland fire may be a tool to reduce shading in some areas.

Northeastern Bulrush

AFFECTED ENVIRONMENT

Unless otherwise noted, the information used in this analysis comes from NatureServe (accessed in 2010).

Northeastern bulrush (*Scirpus ancistrochaetus*) was listed as endangered under the Endangered Species Act in 1991. Populations are known from MA, MD, NH, NY (presumed extirpated), PA, VA, VT, and WV. The habitat seems to vary geographically, although there are not enough sites to allow generalizations to be made. However, one does observe that in the south, sinkhole ponds are the most common habitat for the plant, and in the north, other kinds of wetlands, including beaver-influenced wetlands, provide suitable habitat. When this species was listed as endangered there were 33 known populations. As of 2007, there were about 113 extant occurrences known in the Appalachians from southern Vermont and New Hampshire to western Virginia, with most occurrences in Pennsylvania.

Most populations are in Pennsylvania (70) and Vermont (22) (USFWS 2008). The other populations are in Massachusetts (1), Maryland (1), New Hampshire (9), Virginia (7), and West Virginia (3) (USFWS 2008). There are about ten historical occurrences: New York (1), Pennsylvania (7), Virginia (1), Quebec (1). The plants are restricted to fairly specific wetland habitats that are infrequent, especially in the southern part of the range. Various threats are associated with the habitat, including drainage and development, agricultural runoff, and any developments that could alter the local hydrology. Additional, unsurveyed habitat does exist, and more populations of this species may be found in the future if the potential habitats remain intact.

Long-term monitoring of known sites is needed before any conclusions can be drawn about the habitat needs of the plant, or about the stability of its populations in changing environments.

The implementation schedule for the northeastern bulrush recovery plan (USDI Fish and Wildlife Service 1993) includes five items that directly relate to Forest Service management:

- Secure permanent protection for known populations;
- Resurvey sites thought to have suitable habitat;
- Verify, monitor, and protect any additional populations;
- Identify potentially suitable habitat for additional surveys; and
- Survey potential sites.

Throughout its range, northeastern bulrush is found in open, tall herb-dominated wetlands. Often it grows at the water's edge, or in a few centimeters of water, but it may also be in fairly deep water (0.3-0.9 m) or away from standing water. In the southern part of its range, the most common habitat is sinkhole ponds, usually in sandstone. Water levels in these ponds tend to vary both with the season and from year to year. At least one site (in Massachusetts) is in a sand plain, where water level fluctuates as well. Two sites in Vermont are influenced to some extent by beaver activity as well as other hydrological factors.

With the information available it is difficult to compare sites throughout the plant's range. For example, lists of associated species may represent an entire wetland or the immediate vicinity of the plant, but this is not always possible to determine from available information. Nevertheless, examination of field reports indicates that there is considerable variety in associated species. A few species, however, are common to several of the sites. These are *Dulichium arundinaceum, Scirpus cyperinus sens. lat., Glyceria canadensis*, and *Triadenum virginicum*.

Virginia. There are seven extant northeastern bulrush sites in Virginia, with two ranked as A/AB, two ranked B/BC, and one ranked E. The status of most of these sites is unknown because they have not been surveyed since the 1980s or 1990s. Habitat includes emergent ridgetop shallow ponds, shallow sinkhole depressions

and mountainside bench ponds. Four sites are located on private land, three are on public land, and ownership of one site is undetermined. In Virginia, the northeastern bulrush is listed as State endangered; however, no additional protection (e.g., buffers) is afforded to wetlands supporting the species. No upland buffers are regulated or protected around any wetlands in the State. The northeastern bulrush is protected under the Endangered Plant and Insect Species Act of 1979, which prohibits take without a permit, but individual landowners are exempt from these permitting requirements.

West Virginia. There are three northeastern bulrush populations in West Virginia, two of which are ranked B, and one of which is ranked D. According to the U.S Fish and Wildlife 5-year status review for northeastern bulrush these occurrences were surveyed and last observed in 2005, however, known populations on Forest Service property have been resurveyed (Cipollini and Cipollini 2011) and monitored annually, either by Forest Service personnel or by the West Virginia Department of Natural Resources WVDNR. Habitat includes sinkhole ponds atop a low, flat sandstone ridge, and small seasonal ponds. Two of these sites are located on private lands, and one is located on National Forest land managed by the U.S. Forest Service (USFWS 2008).

The northeastern bulrush has no official status in West Virginia, and this State does not have an endangered species law. No upland buffers are required around any wetlands in the State.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Among the potential human threats are agricultural runoff, construction of logging and fire roads, development, all-terrain vehicle use, collection, and dredging. In addition to human activity, there may be natural threats to the species as well, although more information about the biology and ecology of the species is needed before these threats can be fully assessed. Among possible natural threats are deer, beaver (one Vermont population has suffered fluctuations, apparently as a result of beaver activity), natural water level fluctuations, fire (this may have damaged a population in Pennsylvania), and succession. Fluctuations in population size have been observed at several localities for the species. It is very likely that botanists visiting the known sites for the species do not identify vegetative plants, and it is possible that, in some cases, the fluctuations are in number of flowering/ fruiting culms rather than actual number of plants.

The 5-year review of northeastern bulrush by the USFWS stated that new information indicates that shading may be a threat, "Therefore, in some cases, it may be helpful to manage the habitat surrounding these sites by selectively removing larger trees to reduce canopy cover to increase light exposure" (USFWS 2008). The 5-year review also noted that alterations of the hydrology of wetlands supporting northeastern bulrush could have negative effects.

Exotic organisms may pose threats to northeastern bulrush populations in the near future. Purple loosestrife, *Lythrum salicaria*, is slowly spreading through Virginia and may eventually invade some northeastern bulrush sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth (*Lymantria dispar*) is currently defoliating large areas of the Forest and adjacent lands but it is unclear whether if or how the gypsy moth will negatively impact northeastern bulrush populations.

The known occurrences of this species on the Forest are protected under all alternatives, except A (the 1993 Revised Forest Plan), as management prescription 4D, Special Biological Area. These Special Biological Areas are managed specifically to restore and maintain conditions to benefit the community and/or rare species for which the area was established. Without regular monitoring and maintenance the cumulative impacts of the OHV trail that passes near the pond on Potts Mountain have the potential to negatively affect the pond and the northeastern bulrush through illegal OHV use (or through maintenance of the OHV road affecting the hydrology of the area. The Pond Run Pond site is very near the intersection of two trails that are used by hikers and horses. In the past there has been evidence of horses in the pond basin, although there has been no apparent negative impact to the Northeastern bulrush. In 2009 the U.S. Forest Service constructed a barbed wire fence that is keeping horses out of the pond. Shading has also been a concern at this site and over the past several years a slow process of girdling trees has been occurring that appears to have increased the number of flowering columns.

Madison Cave Isopod

AFFECTED ENVIRONMENT

The Madison Cave isopod was federally listed as a threatened species in 1982. It is an eyeless, unpigmented, freshwater crustacean, belonging to a family that consists of mostly marine species. It is the only free-swimming stygobitic isopod known in the Appalachians (Holsinger et al. 1994). With a maximum length of 0.7 inches, its body is flattened and bears seven pairs of long walking legs; the first pair is modified as grasping structures (USDI 1996).

The Madison Cave isopod is found in flooded limestone caves beneath the Shenandoah Valley in Virginia and West Virginia where it swims through calcite-saturated waters of deep karst aquifers. It is known from 19 caves and wells, spanning a range 150 miles long and less than 15 miles wide, stretching from Lexington, VA to Charles Town, WV (Hutchins et al. 2010). There are documented population centers in the Waynesboro-Grottoes area (Augusta County, VA), the Harrisonburg area (Rockingham County, VA), and the valley of the main stem of the Shenandoah River (Warren and Clarke counties, VA and Jefferson County, WV) (USDI 2009).

The population size of the Madison Cave isopod is unknown at most sites. Sampling results suggest that the population is dominated by adults. It is thought that the isopod has a lengthy life span and low rate of reproduction; it is unknown how this species reproduces. Feeding habits are unknown, but it is believed to be carnivorous (USDI 2009).

Recent genetic studies of the Madison Cave isopod indicate there are three genetically distinct clades corresponding to three geographic groups of sites. The groups are strongly correlated with the geographic pattern of carbonate rock outcropping in the Shenandoah Valley indicating potential barriers to subterranean hydrologic connectivity (Hutchins et al. 2010).

The Madison Cave isopod is not known from the Forest, the closest occurrence is approximately four miles straight line distance to Forest Service land. To date, all known collections of the Madison Cave isopod have come from caves and wells that tap into the karst aquifer(s) hosted by and formed in Cambro-Ordovician aged carbonate bedrock (limestone and dolostone) of the Great Valley province in Virginia and West Virginia. Orndorff and Hobson (2007) combined Great Valley outcrop areas of the following units from the 1993 Geologic Map of Virginia (VA-DMR, 1993) to create a map of potential habitat for Madison Cave isopods in Virginia: Shady Dolomite, Tomstown Dolomite, Elbrook Formation, Conococheague Formation, Upper Cambrian and Lower Ordovocian Formations (undivided), Beekmantown Group (including Stonehenge, Rockdale Run, and Pinesburg Station Formations), and the Edinburg/Lincolnshire/New Market association. The following additional formations have some minor carbonate units, and have a small potential to host the species: Waynesboro Formation, Pumpkin Valley Shale (including Rome Formation). Carbonate rocks in the base of the Martinsburg Formation, immediately adjacent to the Edinburg/Lincolnshire/New Market association, may also host the species, but are generally confined to an area within a few hundred feet of the contact.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The potential habitat described above was divided into high, medium, and low probability of Madison Cave isopod occurrence by the Virginia Division of Natural Heritage (Orndorff and Hobson 2007). The high and medium likelihood potential habitat was intersected with Forest Service land boundaries to determine quantity and quality of potential habitat on National Forest. Only about 300 acres on National Forest System lands are in the high probability potential Madison Cave isopod habitat. About 400 acres are in the medium probability potential habitat. With no known populations on the GWNF and the very limited amount of land in potential habitat, none of the alternatives are expected to have any impact on this species.

The high probability potential habitat is within the Remote Backcountry Management Area Prescription (12D) along the western flank of Massanutten Mountain in all alternatives except Alternative C, where it is in Recommended Wilderness Study. The emphasis for this area is to provide recreation opportunities in large remote, core areas where users can obtain a degree of solitude and the environment can be maintained in a

near-natural state. There is little evidence of humans or human activities other than recreation use and nonmotorized trails.

In Alternatives A, B, D, E, G, H and I the majority of the medium probability potential habitat is within the Pastoral Landscapes and Rangelands Management Area Prescription (7G), along the South Fork Shenandoah River; emphasis is on maintaining high quality, generally open landscapes with a pastoral landscape character. These lands are unsuitable for timber production but allow limited recreational facilities, that might include pullouts, small parking areas, trailheads, bulletin boards, interpretive signage, fence stiles, rail, and other fences, and low development trails. In Alternative C the majority of the medium probability potential habitat is in the Eligible Recreation River Corridor Management Area Prescription (2C3).

The Madison Cave isopod appears to be long-lived and have low reproductive potential, suggesting that populations are highly sensitive to disturbance. As a subterranean aquatic obligate, potential threats include the loss and modification of habitat (including the surface environment that is their primary source of water and nutrients), groundwater contamination, and groundwater drawdown (USDI 1996). Agriculture and encroaching industrial and urban development threaten the quality and quantity of groundwater habitat and thus the survival of this species (USDI 2009).

To protect Madison Cave isopod habitat, the USDI Fish and Wildlife Service (2009) recommends avoiding chemical and fertilizer use where it could enter a waterway that supports the Madison Cave isopod, maintaining a buffer of natural vegetation along waterbodies and sinkholes to control erosion and reduce run-off, not disposing of waste or other material into sinkholes, fencing livestock out of streams, properly disposing of household wastes, including used motor oil, and properly maintaining septic tanks. Forest Service activities meet or exceed all of the above recommendations. Based on the limited amount and type of management proposed in the management prescriptions that intersect with potential Madison Cave isopod habitat, there will be no loss or modification of karst aquifer habitat, groundwater contamination, or groundwater drawdown from Forest Service activities; thus no effect to potential habitat.

The strategy on groundwater issues that cross national forest boundaries and are affected by multiple region-wide impacts such as increased agricultural use, growing urban development, is to focus on sustaining and improving watershed areas within national forest control while working cooperatively with other agencies and landowners to improve statewide watershed health.

The high probability potential Madison Cave isopod habitat identified by Orndorff and Hobson (2007) is 352,205 acres; the Forest Service portion of that is 280 acres, or 0.08%. The medium probability potential habitat is 513,215 acres, with the Forest Service owning 428 acres, or 0.08% (see table below).

Table 3B2-8. Percent Potential Madison Cave Isopod Habitat on the GWNF

Madison Cave Isopod habitat probability	Total acres potential habitat	FS acres potential habitat	Percent potential habitat on FS land
High	352,205	280	0.08
Medium	513,215	428	0.08

The species range is the Shenandoah Valley in Virginia and West Virginia; it is mostly private land, where agriculture, urban and industrial development dominate the landscape. Because there will be no direct or indirect effects to Madison Cave isopod from Forest Service management activities, and only a fraction (less than a tenth of one percent) of potential habitat is on Forest Service land, any cumulative effects to the quality or quantity of Madison Cave isopod habitat will be from private land.

Summary

Table 3B2-9. T&E species, Associated Ecological Systems, and Management Strategies

Species	Ecosystem	Management Strategies
Indiana Bat	Caves and Karstlands	Management Prescription Areas: designation of the primary and secondary Indiana bat cave areas Standards/Guidelines: standards for activities within the primary and secondary Indiana bat cave areas; standards for activities throughout the Forest in regard to leave trees during timber harvest activities Objectives: improvement of habitat through increased open woodlands
Virginia Big-Eared Bat	Caves and Karstlands	Standards: Cave standards
James Spinymussel	Floodplains, Wetlands and Riparian Areas	Standards: Riparian standards
Northern Flying Squirrel	Spruce, Northern Hardwoods	Management Prescription Areas: All known locations are in Special Biological Areas
Shale Barrens Rock Cress	Appalachian Shale Barrens	Management Prescription Areas: All known locations are in Special Biological Areas
Smooth Cone Flower		Management Prescription Areas: All known locations are in Special Biological Areas
Virginia Sneezeweed	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biological Areas Standards: Riparian standards
Swamp Pink	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas: All known locations are in Special Biological Areas Standards: Riparian standards
Northeastern Bulrush	Floodplains, Wetlands and Riparian Areas	Management Prescription Areas All known locations are in Special Biological Areas Standards: Riparian standards
Madison Cave Isopod	Caves and Karstlands	Standards: Cave standards Standards: Riparian standards

B2C – DEMAND SPECIES

The discussions of changes in habitat by alternative in the following sections are based on information from previous sections. The effects of each alternative on key habitat features across ecological forest types are discussed in detail in the Ecosystem Diversity Report (EIS, Chapter 3, Section B1 and Appendix E) and Species Diversity Report (EIS, Chapter 3, Section B2 and Appendix F). Tables 3B1-1, 3B1-2, 3B2-2, and 3B2-3 display Ecosystem and Species Group Indicators that quantify current conditions and desired conditions of these major habitat components, by ecosystem and alternative, over a ten and fifty year period. Unless otherwise noted, figures from these tables are used in the analysis of future trends.

The tables in this section are based on the levels of timber harvest and prescribed fire displayed in Table 3B2-11.

White-Tailed Deer

AFFECTED ENVIRONMENT

White-tailed deer (*Odocoileus virginianus*) use a wide variety of forest types and successional stages to meet their year-round needs. In the central Appalachians, deer are found in all forest types and use various successional stages during their annual life cycle (Johnson et al. 1995; VDGIF 2007; WVDNR 2011). Older forests are important in the fall and winter, when acorns become a dominant fall and winter food item (Wentworth et al. 1990a). Deer nutrition, reproduction, weights, and antler characteristics can be influenced by the availability of acorns (Harlow et al. 1975; Feldhammer et al. 1989; Wentworth et al. 1990a, 1992). Year-round use of vegetation in the form of woody browse, soft mast, forbs and grasses is extremely important and found most abundantly in early successional woody habitat, open woodland, grasslands, and shrublands of varying sizes (Wentworth et al. 1990b; Ford et al. 1993; VDGIF 2007). High quality deer habitat is characterized by the interspersion of mature forested and other habitats that provide not only food sources, but escape cover (VDGIF 2007). In eastern hardwood forests, Barber (1984) recommended that at least 50% of the landscape should consist of mature mast trees, with the remainder containing an interspersion of evergreens, shrubs and vines, and openings with herbaceous and early successional woody vegetation. Based on utilization data, current deer densities in the Southern Appalachians can be maintained by providing approximately 5% of the landscape in regenerating forest vegetation (Wentworth et al. 1990b). Wentworth and others (1989) concluded that approximately 2% of the area in high quality grasslands and shrublands would be necessary to adequately buffer the effects of a poor acorn year.

White-tailed deer are present throughout the Region. Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the Southern Appalachian Assessment area (SAMAB 1996). High population densities are associated with greater amounts of cropland and lesser amounts of developed and coniferous forestland. Current deer densities are generally higher on private lands than on national forest and state lands in Virginia (VDGIF 2007).

FOREST TRENDS

The GWNF comprises approximately 960,000 acres (90%) in thirteen Virginia counties and 105,000 acres (10%) in four West Virginia counties, for a total of 1,065,000 total acres, of which 1,058,000 is forested. There are approximately 240,000 hunters in Virginia and 245,000 in West Virginia that hunt deer (VDGIF 2007, WVDNR 2011). Recreation generated primarily by deer hunting produces approximately $221 million in Virginia and $247 million in West Virginia annually (USFWS 2011). Ninety-two percent of available deer habitat in Virginia exists on private land, whereas eight percent is found on public land (state, federal, other public ownership)(VDGIF 2007). Eighty-seven percent of available deer habitat in West Virginia is also found on private land, with 13 percent on public land (WVDNR 2011).

Virginia. Current population reconstruction models indicate that Virginia's statewide deer population has been relatively stable over the past decade, fluctuating between 850,000 and 1,000,000 animals (VDGIF 2012). In Virginia, deer population trends were evaluated by examining the annual rate of change in the population index (i.e., antlered buck harvest per unit area) over the 10-year period from 2000-2010. An exponential regression (y = aert; where, y = population index, a = intercept, e = 2.718, r = instantaneous rate of change, and t = year) was used to determine trends in population. The annual rate of change (R) = er – 1. The status of the deer population in each county was considered to be increasing or decreasing if the annual rate of change in the population index was >2.26% (either positive or negative) and the statistical significance level of the exponential regression model was p < 0.10 (r2 Value > 0.301). Annual rates of change that exceeded 2.26% represent a change of at least 25% in the population index over the decade (1.022610 = 1.25). Counties that displayed a rate of change between 0 and +2.26 were deemed to be stable. Overall on the GWNF in Virginia, 9 counties, representing 660,476 acres (69% of the 960,000 of total acres in Virginia) demonstrated stable population trends, and 4 counties, representing 295,788 acres (31%) demonstrated decreasing trends. Since 2000, VDGIF harvest data has suggested a more substantial decline across much of the GWNF. In contrast, private land in the same counties ranges from stable to increasing trends (VDGIF 2013).

Table 3B2-10. White-tailed Deer Population Index Trend across the GWNF in Virginia, 2000 to 2010 (Source: VDGIF)

County	Percent GWNF in County	Number of GWNF Acres in County	Ranger Districts Included	R^1	p^2 Value	Status
Allegheny	49	141,873	James River, Warm Springs	-3.23%	0.180	Stable
Amherst	19	57,877	Pedlar	-6.90%	0.762	Decreasing
Augusta	30	196,057	North River, Pedlar	-1.80%	0.168	Stable
Bath	51	173,705	North River, Warm Springs	-4.70%	0.299	Stable
Botetourt	4	13,047	James River,	-3.04	0.325	Decreasing
Frederick	2	4,885	Lee	-4.58	0.297	Stable
Highland	22	58,267	North River, Warm Springs	-4.80%	0.269	Stable
Nelson	7	19,825	Pedlar	-4.39%	0.254	Stable
Page	13	27,082	Lee	-0.12%	0.002	Stable
Rockbridge	12	45,542	North River, James River, Pedlar	-3.85%	0.374	Decreasing
Rockingham	25	139,783	North River, Lee,	-5.15%	0.545	Decreasing
Shenandoah	23	76,057	Lee	-1.98%	0.284	Stable
Warren	5	6,290	Lee	2.95%	0.150	Stable

[1] *R* = Percent annual change in population index. Values less than -2.26% and values greater than 2.26% are considered significant ($1.0226^{10} = 1.25$ or a 25% increase or decrease over the 10-year period).
[2] *p* = Statistical significance level of exponential regression model. Values ($p < 0.10$) are considered significant.

Statewide, VDGIF reports an 8% decrease in total number of deer harvested in 2012 compared to 2011, with the total number harvested 8% below the last 10-year average of 232,573. The Department's primary deer management effort over the past five years has been to increase the female deer harvest over much of the state, especially on private lands. This higher level of deer harvest is intended to lead to a decrease in the statewide deer herd. The deer harvest totals over of the past three years would appear to suggest these management efforts have been successful (VDGIF 2013).

West Virginia. From 1945 through 2010, a total of 5,472,196 deer have been harvested in West Virginia, with 50% of the total recorded deer harvest during the period occurring in the last 15 years (WVDNR 2011). West Virginia estimates their current deer population as an index of antlered deer harvest. Estimated deer per square mile of land in West Virginia increased steadily from 1945 to 2001 to a peak of 43 deer/square mile, then declining from 2002 to 2010 to an estimated 25 deer/square mile or less (WVDNR 2011). As a basis for comparison with Virginia deer trends in terms of total deer harvested, West Virginia reported an increasing total of 150,000 to 250,000 annually from 1993 – 2002, then a decreasing total of 200,000 to 125,000 annually from 2002 – 2010.

Virginia's revised Deer Management Plan has an objective to stabilize deer populations on public land in western Virginia (VDGIF 2007). West Virginia's Revised Deer Management Plan has an objective to maintain a healthy deer population at levels compatible with biological and sociological conditions, while providing a diversity of hunting opportunities and other associated recreational benefits (WVDNR 2011). Both revised Deer Management Plans recommend supporting habitat management objectives on public lands that manipulate vegetation for early successional wildlife and promote restoration, regeneration, and productivity of plant species important to wildlife, particularly those that provide diverse hard and soft mast (e.g., American chestnuts, acorns, grapes, and berries). Deer densities are normally greater in areas of high quality browse, hard mast production of both red and white oaks, and well distributed, high quality grassland/shrublands. These conditions are most influenced by soil fertility and are more common where there is an intermingled ownership of private and National Forest System lands. Many deer populations, especially on private land, have experienced steady increases over the past decades (VDGIF 2007; WVDNR 2011). Deer densities are managed in part by controlling the number of antlerless deer hunting days. Liberalized hunting regulations over several years appear to have stabilized the herd growth for most areas in Virginia, especially on private land (VDGIF 2013).

Chronic Wasting Disease (CWD) was discovered in the deer population in Hampshire County, WV in 2005 and 2009 in Frederick County, VA (WVDNR 2011; VDGIF 2013). CWD is a fatal neurological disease impacting deer and other large herbivores such as elk and moose (VDGIF 2013). The long-term impacts to deer, elk, and moose populations are of serious concern to state and federal wildlife management agencies. A deer infected with CWD may take up to 5 years to show symptoms; CWD can be spread through deer to deer contact, as well as through contaminated soil and other surfaces (VDGIF 2013). Currently, there is no evidence that CWD is transmissible to humans, pets, or livestock, but public health officials recommend that human exposure to the CWD agent be avoided in areas where CWD in deer populations is documented (VDGIF 2013). A CWD Containment area has been established in portions of Hampshire, Hardy, and Morgan counties in West Virginia, and portions of Frederick and Shenandoah counties in Virginia. These containment areas include portions of the Lee ranger district on the GWNF. Personnel with the GWNF are working cooperatively with both state agencies as they enact their CWD Response Plans.

VDGIF deer management objectives are based on the Cultural Carrying Capacity (CCC) and are intended to stabilize the deer population on public lands on all thirteen Virginia counties of the GWNF (VDGIF 2007). WVDNR deer management objectives are aimed to be compatible with biological and sociological conditions and are defined by administrative district (WVDNR 2011) The quality of deer habitat has declined in recent years on GWNF lands in many western Virginia and eastern West Virginia counties because of maturing forest habitat conditions, declining early successional woody habitat for browse and cover, and a declining number of maintained grassy/shrubby openings. The Virginia Department of Game & Inland Fisheries (VDGIF) and West Virginia Division of Natural Resources recommends implementation of habitat management improvements that are beneficial to deer on over 1% annually of the total GWNF acreage (VDGIF 2011; WVDNR 2011). This includes an increase in timber harvest and prescribed fire that creates early successional woody and open woodlands habitat, and restoration and maintenance of grasslands and shrublands. Such habitat creation should be well dispersed across the otherwise mature forested landscape of the GWNF.

DIRECT AND INDIRECT EFFECTS

Deer habitat quality and numbers are directly associated with soil quality, habitat type, successional stage, and the amount of habitat interspersion or edge (VDGIF 2007). The importance of a diversity of hard mast producers, successional habitat for browse, and grasslands/shrublands, each being well distributed across the landscape to meet the year-round needs of deer, has been previously discussed. The effects of each alternative on key habitat features across ecological forest types are discussed in detail in the Ecosystem Diversity Report (EIS, Appendix E) and Species Diversity Report (EIS, Appendix F). Tables 3B1-1, 3B1-2, 3B2-2, and 3B2-3 quantify current condition and desired conditions of these major habitat components, by ecosystem and alternative, over a ten and fifty year period.

Table 3B2-11 depicts the acres of active management activities planned annually under each alternative. The four activities that have the greatest influence on deer habitat quality is early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Table 3B2-11. Planned Annual Activities in acres, by Alternative

Active management activities	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Timber regeneration harvest	2,400	700	1,800-3,000	0	3,000-5,000	1,800-3,000	1,000-1,800	1,800-3,000	1,800-3,000
Prescribed fire	3,000	7,400	12,000-20,000	0	5,000-12,000	20,000	12,000-20,000	12,000-20,000	12,000-20,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving deer habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2007). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for deer. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for deer and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for deer. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat Dense grassy/shrubby escape cover for fawns vulnerable to predators such as coyotes and black bears is more effective when it is in a 500 to 1,000 acre patch of open woodlands (average prescribed burn block) than a 25-40 acre patch of early successional forest habitat (average timber treatment unit) or a 1-5 acre grassland/shrubland patch (average size of wildlife opening).

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 acres at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands. The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 86% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for white-tailed deer (VDGIF 2007).

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

Land ownership patterns. Land ownership patterns on the GWNF are characterized by a high percentage of ridges and sideslopes, with less than 10% percent in valley land. Valley land has historically been more profitable to own and has therefore tended to stay in private ownership. In the ridge and valley areas of Virginia and West Virginia, valley lands are characterized by a mixture of open fields, crops, some woodlands, and farms and communities. Deer populations routinely forage in the mix of valley habitats and move upslope onto mostly forested ridges and sideslopes to rest and forage when hard mast is seasonally available (Knox 2012; WVDNR 2011). Since much of the valley land where GWNF lands are found is privately owned, it is reasonable to assume many deer herds on the GWNF incorporate some percentage of adjacent private land in their home ranges. Mixed ownership patterns can affect deer population distribution on the GWNF in several ways. A mix of habitats may be provided on adjacent private lands that can help meet forage needs for deer along the public/private ownership zone Deer movement on and off GWNF lands and adjacent private lands can potentially cause damage to crops and pastures, becoming a nuisance to private landowners. Such movements can result in private landowner requests for kill permits and demands for increased harvest objectives on private lands to address these issues (Knox 2012; VDGIF 2007). The opportunity for hunting deer on the GWNF can be positively affected by increased foraging opportunities to local deer herds from adjacent private land, and can also be negatively affected by lower deer populations on GWNF, due to higher harvest objectives and kill permits on adjacent private lands where deer are consider a nuisance. Increased early successional habitat, open woodlands, and grasslands on GWNF in a number of alternatives will help provide year-round habitat for deer populations, but with the high amount of adjacent private land ownership in predominately richer valley habitat, it is reasonable to expect deer herds to continue moving on and off GWNF lands and adjacent private land as part of their home ranges, and therefore be impacted by higher private land harvest objectives and deer kill permits.

Predation and disease. In addition to habitat quality, white-tailed deer populations can be regulated by other factors, such as predation and disease. In recent decades, both black bear and coyote populations have increased across the state of Virginia and are known to opportunistically prey on white-tailed deer, especially fawns and older or diseased adults (Knox 2011; VDGIF 2012). The current and long-term impacts of these and other predators on the white-tailed deer population are unknown at this time (Knox 2011). Chronic Wasting Disease (CWD) was discovered in the wild deer population in Hampshire County, WV in 2005 and 2009 in Frederick County, VA (WVDNR 2011; VDGIF 2013). CWD is a fatal neurological disease impacting deer and other large herbivores such as elk and moose (VDGIF 2013). The long-term impacts to deer, elk, and moose populations are of serious concern to state and federal wildlife management agencies. A deer infected with CWD may take up to 5 years to show symptoms; CWD can be spread through deer to deer contact, as well as through contaminated soil and other surfaces (VDGIF 2013).

Deer browse impacts. Deer are large herbivores and their browsing activities can affect both plant and animal communities, either directly or indirectly (VDGIF 2007). Deer populations can increase to the point of exceeding the biological carrying capacity (overpopulation) of the area, where development of early successional habitat for food and hunting are not allowed (VDGIF 2007). Some plants of the families Liliaceae and Orchidaceae can be especially vulnerable to deer browse. The goal of both VDGIF and WVDNR is to

manage each state's deer population through hunting and other regulations to moderate populations below the biological carrying capacity (VDGIF 2007; WVDNR 2009). National Forest System lands receive annual hunting to control deer densities, with the goal of preventing over-population of these areas and thus reduce negative effects of browse pressure on plant diversity and protect the viability of herbaceous ground flora in these areas.

In summary, the combination of habitat components important for white-tailed deer habitat are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, G, H and I. In response to increased favorable habitat conditions, white-tailed deer populations would be expected to stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, white-tailed deer populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest. Under all alternatives, the high percentage of public/private interface on the GWNF will impact the deer population along this interface, as long as adjacent private lands have higher harvest objectives and are allowed kill permits in response to damage complaints.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for white-tailed deer. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including white-tailed deer. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for white-tailed deer at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term deer populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, H, I and D. Long-term deer populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Table 3B2-12. Projected Habitat Components in Acres and Percentage of Forested Landscape at 10 years by Alternative

Habitat Component	Units	Current Conditions	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Early Successional Forest from Natural Disturbances	Acres	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Early Successional Forest from Timber Harvest	Acres	13,600	24,000	7000	18,000-30,000	0	30,000 - 50,000	18,000-30,000	10,000-18,000	18,000-30,000
	%	1%	2%	1%	2-3%	0%	3-5%	2-3%	1-2 %	2-3%
Open Woodlands from Natural Disturbances	Acres	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Open Woodlands from Prescribed Fire	Acres	22,500	35,900	53,600	64,500 - 99,000	6,100	43,900 - 64,500	99,000	64,500 - 99,000	64,500 - 99,000
	%	2%	3%	5%	6 - 9%	1%	4 - 6%	9%	6 - 9%	6 - 9%
Grassland/ shrublands	Acres	4,300	5,400	5,800	6,700	3,400	6,000	6,700	6,700	6,700
	%	0%	1%	1%	1%	0%	1%	1%	1%	1%
Total acres of combined active management habitat components	Acres	40,300	65,300	66,3008	89,200 - 135,700	9,500	79,800 - 120,500	123,700 - 135,700	81,200 - 123,700	89,200 - 135,700
	%	4%	6%	6%	8 - 13%	1%	8 - 11%	12 - 13%	8 - 12%	8 - 13%
Mid- to late successional Hard Mast Producing Forest	Acres	937,800	927,300	950,400	921,300	951,300	908,300	933,300	941,300	921,300
	%	89%	88%	90%	87%	90%	86%	88%	89%	87%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Table 3B2-13. Projected Habitat Components in Acres and Percentage of Forested Landscape at 50 Years by Alternative

Habitat Component	Units	Current Conditions	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Early Successional Forest from Natural Disturbances	Acres	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900	16,900
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Early Successional Forest from Timber Harvest	Acres	13,600	24,000	7,000	18,000-30,000	0	30,000 - 50,000	18,000-30,000	10,000-18,000	18,000-30,000
	%	1%	2%	1%	2-3%	0%	3-5%	2-3%	1-2 %	2-3%
Open Woodlands from Natural Disturbances	Acres	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800	19,800
	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Open Woodlands from Prescribed Fire	Acres	22,500	42,700	87,400	108,700 - 170,600	12,200	66,600 - 108,700	170,600	108,700 - 170,600	108,700 - 170,600
	%	2%	4%	8%	10 - 16%	1%	6 - 10%	16%	10 - 16%	10 - 16%
Grassland/ shrublands	Acres	4,300	5,500	6,400	8,100	3,500	6,900	8,100	8,100	8,100
	%	0%	1%	1%	1%	0%	1%	1%	1%	1%
Total acres of combined active management habitat components	Acres	40,300	72,300	100,800	134,800 - 208,800	15,800	103,500 - 165,500	196,700 - 208,700	126,800 - 196,700	134,800 - 208,700
	%	4%	7%	10%	13 - 20%	2%	10 - 16%	19 - 20%	12 - 19%	13 - 20%
Mid- to late successional Hard Mast Producing Forest	Acres	937,800	927,300	950,400	921,300	951,300	908,300	933,300	941,300	921,300
	%	89%	88%	90%	87%	90%	86%	88%	89%	87%

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Eastern Wild Turkey

AFFECTED ENVIRONMENT

Eastern wild turkey (*Meleagris gallopavo*) occupies a wide range of habitats, with diversified habitats providing optimum conditions (Schroeder 1985; VDGIF 2013). This includes mature mast-producing stands during fall and winter, shrub dominated stands for nesting, and herb dominated communities, including grasslands, for brood rearing. Habitat conditions for wild turkey can be enhanced by management activities such as prescribed burning and thinning (Hurst 1978; Lafon et al. 2001; Norman et al. 2001; Pack et al. 1988; Steffen et al. 2002; VDGIF 2013), and the development of herbaceous openings (Nenno and Lindzey 1979; Healy and Nenno 1983).

For the eastern hardwood region, Wunz and Pack (1992) recommended maintaining 50 to 75% of the area in mast producing condition and approximately 10% in well distributed permanent grassland/shrublands and/or open woodlands, in addition to the early successional woody habitats that result from timber harvest and other activities. Forest thinning is recommended to enhance the herbaceous component of mid-successional forests. Prescribed burning to create and maintain open woodland structural conditions is important for brood and year-round foraging habitat. Other important habitat components include spring seeps, especially in areas with regular snow cover, and a diversity of soft mast producing plants (e.g. dogwood, black gum, grape, blueberries, etc.). Especially in northern hardwoods and high elevations in western Virginia, conifer cover (e.g., pines, cedars) provides an important roosting habitat for wintering birds (VDGIF 2013).

Eastern wild turkeys are present throughout the Region. Population densities generally are medium to high in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, and Southern Appalachian Piedmont Sections, and low to medium in the remainder of the SAA area (SAMAB 1996; VDGIF 2013). High population densities are associated with greater amounts of oak forest and cropland, and lesser amounts of developed and coniferous forestland. Wild turkey populations have expanded in range and density in the last 25 years. As with deer, this increase likely is related to both nonhabitat factors such as extensive restoration efforts, protection, and conservative harvest strategies as well as increased acorn capability resulting from the increase in mid-to late successional oak forests.

FOREST TRENDS

Wild turkey population trends are monitored by the Virginia Department of Game and Inland Fisheries (VDGIF) and West Virginia Division of Natural Resources (WVDNR). Population trends, in terms of harvest/square mile, vary over the years, but indicate an overall stable to decreasing trend in counties with GWNF lands. WVDNR reported a decreasing trend in spring gobbling rate in 2012 (34.8 gobblers heard/ 100 hours), which was 17% lower than 2011 and 34% lower than the 30 year average of 52.6 gobblers heard/100 hours (WVNDR 2013). Total turkey brood observations in 2012 were 38.8% less than the 5-year average.

Table 3B2-14. Population Trends Based on Spring Gobbler Harvest on Counties with GWNF in Virginia, 2003-2012 (Source: VDGIF 2013)

County	Population Growth		
	Annual Growth (%)[1]	P-Value[2]	Trend Status[3]
Allegheny	-4.4	0	Decreasing
Amherst	-5.8	0.005	Decreasing
Augusta	-1.7	0.452	Stable
Bath	-6.4	0.012	Decreasing
Botetourt	-4.1	0.03	Decreasing
Frederick	-2.3	0.237	Stable
Highland	-3.7	0.22	Stable

County	Population Growth		
	Annual Growth (%)[1]	P-Value[2]	Trend Status[3]
Nelson	-3.3	0.068	Decreasing
Page	-3.8	0.15	Stable
Rockbridge	-3.2	0.016	Decreasing
Rockingham	-7.7	0	Decreasing
Shenandoah	-1.7	0.44	Stable
Warren	1.4	0.515	Stable

[1] Based on the 10-year (2003-2012) exponential regression, $N_{10}=N_0*I^{10}$; where N_0 = spring gobbler kill in 2012, N_0=spring gobbler kill in 2003, and I = finite population rate of change. The average growth rate (R) is: R = 100*(I -1).
[2] Probability that the growth trend was not significant.
[3] Trends that were either not significant (P>0.1) or had annual growth between -2.0% and 2.0% were considered stable. Counties with significant trends (P<0.1) and rates that exceeded 2.0% growth were considered increasing. Decreasing counties had significant growth rates less than -2.0%.

DIRECT AND INDIRECT EFFECTS

Wild turkeys require a mixture of various successional stage habitats to meet their year-round habitat needs, as previously mentioned. Key requirements include the interspersion of mature mast producing forest during fall and winter, early successional woody habitat, grassland/shrublands and open woodlands for nesting (early successional habitat), and grasslands and open woodlands for brood range and year-round foraging (Lafon et al. 2001; Norman et al. 2001; Steffen et al. 2002; VDGIF 2013).

Four management activities that have a significant influence on wild turkey habitat quality are early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving wild turkey habitat depends on many factors, including site quality,

stand conditions, and fire prescriptions (VDGIF 2010). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape can provide high quality year-round food, nesting, brood-rearing habitat, and seasonal cover for wild turkeys. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for wild turkeys and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for turkeys.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands (Table 3B2-12). The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 86% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for wild turkeys.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

The availability of grasslands/shrublands, open woodlands, and early successional woody habitat for nesting, brood range, and year-round forage is the most limiting factor to wild turkey populations on the GWNF (VDGIF 2013). The combination of habitat components important for wild turkeys are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, G, H and I. Wild turkey populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, wild turkey populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for wild turkey. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including wild turkey. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for wild turkey at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term wild turkey populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, H, I and D. Long-term wild turkey populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Ruffed Grouse

AFFECTED ENVIRONMENT

Ruffed grouse (*Bonasa umbellus*) utilize a variety of forest habitats, as well as openings within the forested landscape (ACGRP 2004; Harper et al. 2005). Each season brings changes in biological activities of ruffed grouse and the environment in which they live. In the Appalachians, grouse adjust by using forest stands with seasonal foods in or near adequate cover. Ruffed grouse reproduction, recruitment, and survival determine year-to-year grouse abundance. Lack of nutritious food and suitable cover are often cited as limiting factors for Appalachian grouse populations. The location, proximity, and design of active forest management, with respect to seasonal habitat requirements, in large part determine the success of ruffed grouse populations. Important components of grouse habitat include an interspersion of mesic forests with herbaceous ground cover, young hardwoods 3-20 years old with high stem densities, mature stands with mast producing trees, and grassland/shrublands, open woodlands, and gated forest roads with abundant legumes and other forbs.

Nesting cover generally is located in poletimber or larger hardwood stands (Harris 1981; Thompson and Dessecker 1997). Haney (1996) also reported use of mature cove hardwood forests in the Southern Appalachians for nesting and brood rearing.

Some key features of brood cover are security and an abundant high protein food source. Insects are most abundant in habitats characterized by dense herbaceous vegetation (Dimmick et al. 1996). Thompson and Dessecker (1997) describe brood cover as 3-7 year-old regenerating stands containing significant herbaceous component through shrub dominated old fields and herbaceous openings such as grasslands, open woodlands, and sides of roads. Dimmick and others (1996) suggest that the lack of interspersion of areas with a well-developed herb layer and areas of high stem density for protective cover may be one of the limiting factors in southeastern grouse populations. They suggest that brood habitat could be enhanced by the conversion of logging roads and log landings to linear food plots by planting clover/grass mixtures, which would provide bugging areas in close proximity to secure cover.

Adult cover, including drumming habitat, usually consists of young regenerating forest (6-15 year-old) or shrub cover (Thompson and Dessecker 1997). The dense cover provides protection from both avian and mammalian predators. Secure cover is provided in habitats with good vertical structure (8,000+ stems/acre) of 15-20 foot saplings (Kubisiak 1989). Dimmick and others (1996) reported that males began to orient their drumming sites around or in clearcuts within 3 years post-harvest. In Georgia, drumming habitat was associated with the presence of a relatively dense understory of heath shrubs; primarily flame azalea and mountain laurel (Hale et

al. 1982). No strong preference for timber types or stand condition classes was evident. Harris (1981) found that males preferred upland hardwood sawtimber, generally associated with evergreen shrub thickets during the breeding and post breeding seasons.

Dimmick and others (1996) found that breeding male density (based on drumming counts) increased significantly in response to clearcutting in Tennessee. A similar response to timber harvest was reported from oak-dominated forests in Missouri (Wiggers et al. 1992). Highest grouse densities occurred where 7-to-15 year-old hardwood regeneration comprised greater than 14% of the area.

In oak forests of the Central Hardwood region, Thompson and Dessecker (1997) recommended managing on an 80-year rotation that would maintain approximately 15% of the forest in brood or adult cover (3-15 years old). Appropriate regeneration methods include clearcut, seedtree, and shelterwood. Residual basal areas should not exceed 20 square feet per acre. Cutting units should be > 5 acres, and preferably 10-40 acres in size. Group selection is not recommended since the regeneration patches are too small to provide large enough patches of contiguous habitat. In oak-hickory forests, hard mast (acorns and beechnuts) is a critical winter food for grouse. Therefore, it is important to juxtapose mature oak stands adjacent to timber treatments so foraging opportunities for acorns and other mast are not limited (ACGRP 2004; Harper et al. 2005). Positioning timber treatments mid-slope can provide important escape cover for grouse traveling between ridge-top drumming sites, roost sites, and bottomland foraging sites. Another important consideration is to regenerate or, at least, to thin stands along riparian zones, which are preferred habitats for ruffed grouse during winter and summer when a dense stem density is present. Thinning forest stands can improve ruffed grouse habitat if those species that do not produce preferred food resources (e.g. maples, yellow poplar, ashes, and sourwood) are targeted for removal, while more desirable species (e.g. oaks, black cherry, serviceberry, birches, American beech) are retained. Thinning allows increased sunlight into the forest stand, stimulating understory vegetation. Typically, mesic sites will produce more herbaceous vegetation, while xeric sites will produce more woody cover. Regardless of site, soft-mast production by species such as blueberry, huckleberry, blackberry, and raspberry can be expected to increase 2-5 years post treatment. Where riparian issues do not allow removal of timber, 'wildlife' cuts, in which selected trees are cut and left on site, or girdled to become snags, is an alternative method to regenerate or thin along riparian zones (ACGRP 2004; Harper et al. 2005).

Although once commonly used, fire has been suppressed in the Appalachian region for at least 80 years, altering many of the associated forest types and wildlife communities (ACGRP 2004; Harper et al. 2005). Prescribed fire has proven beneficial for ruffed grouse, particularly in oak-hickory forests where burning can enhance brooding habitat. Grouse broods in the Appalachians select areas with abundant herbaceous vegetation, especially forb and fern cover, but also low-growing woody cover, such as blueberries and huckleberries. Prescribed fire in the Appalachians is restricted primarily to oak-hickory forests and other forest types associated with southern and western exposures and ridgetops. This offers numerous opportunities for habitat enhancement, especially where oak-hickory forests comprise 50 percent or more of the available forest cover. When burning oak-hickory stands, fire often feathers into coves and more mesic forest types, but intensity is much less due to more moisture. In fact, when burning relatively large areas (200 or more acres, which is usually necessary on National Forests where there is a lack of roads or firebreaks), coves, creeks, and northern/eastern exposures are commonly used as natural firebreaks. This provides a mosaic of conditions across the burned area, which can be favorable for ruffed grouse for both winter foraging and brooding habitat. Following prescribed fire, areas supporting a diverse herbaceous community can by utilized almost exclusively by grouse broods during the critical summer months. Utilizing prescribed fire after silvicultural treatments (e.g. clearcuts and shelterwood with reserves) to enhance oak regeneration, also improves grouse habitat by increasing invertebrate abundance and soft mast-producing plants. Basal area will fluctuate among sites, but reducing the canopy closure to 60-80 percent normally allows sufficient sunlight into the forest floor to develop the desired structure for brood habitat and will also promote additional soft mast production. The natural mosaic pattern of fire intensity created by prescribe fire across a forested landscape (especially in larger fire areas) often creates small patches of young forest on southern and western facing slopes, which further enhances ruffed grouse habitat. In areas where silvicultural treatments are not economical, or restricted for other reasons, prescribed fire is a critical tool for creating and maintaining ruffed grouse habitat (ACGRP 2004; Harper et al. 2005).

Forest roads (access routes) and grassy/herbaceous openings can provide critical habitat for ruffed grouse in the central and southern Appalachians (ACGRP 2004 and Harper et al. 2005). Forest roads and openings can be an important foraging habitat, especially within oak-hickory dominated forests during years with little mast. Ruffed grouse hens will utilize forest roads in the fall and winter and during the breeding season. Grouse forage on herbaceous material dominated by clover, cinquefoil, birdsfoot trefoil, coltsfoot, and wild strawberry. In most areas where grouse are found in the Appalachians, forest roads and openings comprise less than 1 percent of the land cover. Because they are such a critical habitat, managing roads and openings is paramount to ruffed grouse habitat.

Dominant fall and winter foods in the Southern Appalachians include leaves and fruits of greenbrier (*Smilax* spp.), the leaves of mountain laurel (*Kalmia latifolia*), fruits of grapes (*Vitis* spp.) and oaks (*Quercus* spp.), and Christmas fern (*Polystichum acrostichoides*) (Seehorn et al. 1981). Similarly, Stafford and Dimmick (1978) reported that greenbrier, mountain laurel, and Christmas fern were the dominant fall and winter food items in the Southern Appalachian region of Tennessee and North Carolina. When available, acorns comprise a significant proportion of the diet (Seehorn et al. 1981; Servello and Kirkpatrick 1987; Kirkpatrick 1989; Thompson and Dessecker 1997). They provide a high energy food source during the critical winter period when forage quality is limited (Servello and Kirkpatrick 1987; Kirkpatrick 1989). However, lack of secure cover in open oak stands may limit their use by grouse (Stafford 1989; Thompson and Dessecker 1997). Kubisiak (1985) suggested that 40-60% of a compartment be maintained in stands of mast-bearing age.

Ruffed grouse are found primarily in the Northern Ridge and Valley, Allegheny Mountains, Northern Cumberland Mountains, Blue Ridge Mountains, Northern Cumberland Plateau, and Southern Cumberland Mountains (SAA Terrestrial Report, pgs. 66-67). Low density populations also extend into the adjacent portions of the Central Ridge and Valley, Southern Cumberland Plateau, Southern Ridge and Valley, and Southern Appalachian Piedmont. Population densities generally are moderate in the Blue Ridge Mountains and low to moderate elsewhere. Current grouse densities generally are higher on national forest system lands, national parks, and the Cherokee Indian Reservation than on other ownerships. However, grouse population densities have declined over the last 25 years. The declining trend likely is largely due to the reduction of forest cover in the sapling-pole successional class, which is important to this species.

FOREST TRENDS

Areas of quality grouse hunting are in short supply today and do not meet hunter demands because of very limited habitats where they exist. Ruffed grouse populations on the GWNF appear to have declined over the last two decades as they have throughout the Southern Appalachians. In a recent Virginia monitoring study, the average flushing rate of grouse by participating hunters was 0.57 birds/hr. between 2010-2011 (Norman 2012). This is compared to the long-term flushing rate of 1.10 birds/hr. (1973-2010) and the average flushing rate of the past five years of 0.74 birds/hr. Trends and flushing rates reported by Virginia grouse hunters are similar to most states in the Mid-Atlantic region in recent years. In contrast to the flushing rate trends, results of recent population monitoring, based on spring drumming counts, indicate a more stable population (Norman 2012). The spring 2011 breeding population index was similar to the 2010 index. Likewise, the number of ground drumming per hunt by turkey hunters in the spring gobbler season increased slightly. While recent trends in breeding grouse population trends are encouraging, they are nevertheless significantly below historical levels. Trend analysis over the past 15 years suggest significant long-term annual declines in grouse breeding population levels based on drumming indices from roadside surveys (-3.4%) and spring gobbler hunter surveys (-3.4%) in Virginia (Norman 2012). Much of this decline is attributable to reduced availability of hardwood shrub-sapling habitat due to reductions in timber harvest levels across the Appalachian population, including the GWNF. Recent habitat trends have moved more toward mid to late successional forests with more than 87% of the forest exceeding 60 years of age and only 3% less than 20 years of age. Optimum habitat conditions consist of a variety of habitats and successional stages including 40-60% in mid-late successional forest for mast production and nesting, approximately 15% in (6-15 year old) early successional deciduous forest patches capable of producing 20-25,000 woody stems per hectare (Gullion 1984a; Kubisiak 1985; Stoll et al. 1999; Dimmick et al. 1998; Dessecker 2001) and shrub dominated old field habitats. Permanent openings are normally either too large, too open, or do not have thick escape cover nearby to be

considered optimum for grouse use. Mortality from avian and mammalian predators is also a significant factor limiting grouse populations in the Southern Appalachians (Reynolds et al. 2000).

DIRECT AND INDIRECT EFFECTS

The four activities that have the greatest influence on ruffed grouse habitat quality are early successional forest created by timber management, brood habitat created and maintained through prescribed fire, grassland/shrubland and open woodland restoration and maintenance, and mid- to late- successional hard mast producing forest.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Prescribed fire and open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving ruffed grouse habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (ACGRP 2004; Harper et al. 2005). Prescribed fire often feathers into coves and more mesic forest types, but intensity is much less due to increased moisture. In fact, when burning relatively large areas (200 or more acres, which is usually necessary on national forests where there is a lack of roads or firebreaks), coves, creeks, and northern/eastern exposures are commonly used as natural firebreaks. This provides an exceptional mosaic of conditions across the burned area, which is quite favorable for ruffed grouse for both winter foraging and brooding habitat. Following prescribed fire, areas supporting a diverse herbaceous community can by utilized almost exclusively by grouse broods during the critical summer months. Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for ruffed grouse and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for ruffed grouse.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands (Table 3B2-12). The alternative with the highest

projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 86% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and seasonal cover for ruffed grouse.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

The availability of early successional woody habitat, interspersion of suitable grasslands/shrublands, and open woodlands for nesting, brood range, and year-round forage and cover are the most limiting factors to ruffed grouse populations on the GWNF. The combination of habitat components important for ruffed grouse are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) or stay relatively stable (mid- to late-successional mast producing forest) over the next 10 years under Alternatives B, D, E, F, G, H and I. Ruffed grouse populations should stabilize and/or increase under these alternatives over the next decade. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. Mid- to late successional mast producing forest should stay relatively stable for both alternatives. Under these two alternatives, ruffed grouse populations should stabilize and/or decrease over the next decade, due to lack of available habitat components other than mid- to late successional mast producing forest.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for ruffed grouse. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including ruffed grouse. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for ruffed grouse at year 50 up to 208,700

acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term ruffed grouse populations should be expected to stabilize and possibly increase under Alternatives B, E, F, G, H, I and D. Long-term ruffed grouse populations should be expected to decrease due to lack of available high quality habitat under Alternatives A and C.

Black Bear

AFFECTED ENVIRONMENT

The black bear (*Ursus americanus*) uses a wide variety of habitats in the southern Appalachians, occurring on National Forests and National Parks of the Southern Blue Ridge, Northern Cumberland, and Allegheny Mountains and the Northern Ridge and Valley. These public lands in Virginia, West Virginia, North Carolina, Tennessee, and Georgia connect to form a forested landscape of over 6 million acres where bears are generally distributed at low to medium densities. The increase of older oak forests in this large block of habitat, along with increased protection and conservative hunter harvest, has allowed bear populations throughout the southeastern mountain region to moderately increase over the past 30 years. Bears generally are absent from the Cumberland Plateau, Southern Cumberland Mountains, and Piedmont (SAMAB 1995:61). In the Central and Southern Appalachians, including the GWNF, important habitat elements are habitat remoteness, habitat diversity, den site availability, and availability of hard mast.

Black bears are opportunistic omnivores and consume a variety of seasonal plant and animal foods including flowering plants, grasses, various roots and tubers, and especially soft mast (grapes, berries, apples, etc.). More than 75% of the annual black bear diet consists of vegetative matter; the other 25% consists mostly of insects, insect larva, carrion, and small rodents and other mammals such as groundhogs, deer, and occasionally livestock (VDGIF 2013). Availability of hard mast (acorns and hickory nuts) is critical throughout the winter, and reproductive success can be closely related to this food source (Eiler 1981; Wathen 1983; Eiler et al. 1989, VDGIF 2013). Total production of hard mast and production by individual trees can fluctuate from year to year due to climatic and other factors (Downs and McQuilkin 1944; Fowells 1965). During time of poor mast crops, drought during summer months, and times of the year when food is naturally scarce (early spring), bears may forage around areas of human habitation and are more likely to impact agricultural crops, bee hives, livestock, and other food associated with humans (garbage, birdseed, pet food)(VDGIF 2013). Since bears utilize nearly any abundant plant or animal food, they are likely to thrive when a diversity of forest age classes and food sources are available. Vegetation management can provide much of this diversity (Reagan 1990; VDGIF 2013). Naturally occurring events such as ice storms, wildfires, and hurricanes provide habitat diversity, but at random intervals and locations, making benefits sometimes limited and unreliable.

Bears den in a wide variety of sites including bush piles, large snags, rock cavities and crevices, road culverts, abandoned buildings, and in vegetation (Carlock et al. 1983; VDGIF 2013). In western Virginia, nearly 70% of all dent sites are in hollow trees (VDGIF 2013). Large northern red and chestnut oaks are almost exclusively selected as den trees. Den re-use in Virginia is less than 10%, although some bears may prefer the same type of den (e.g. trees, rock cavities) year after year. Preference may be related to availability and may be a learned behavior (Brody 1984). Timing of den entrance depends upon age, sex, female reproductive status, weather conditions, and food availability (VDGIF 2013). Bears my enter winter dens earlier during poor mast years, which conserve accumulated resources. When mast crops are good, bears typically enter dens later in order to take advantage of additional opportunities to feed and gain weight. During particularly mild winters, some bears (especially males and females with yearlings) may not den at all. Usually pregnant females enter dens first, followed by subadults, then adult males. Individual bears enter dens in Virginia and West Virginia as early as the end of October and as late as the beginning of January (VDGIF 2013). Den emergence usually occurs in reverse order of den entrance. Females with cubs are the last to emerge from winter dens, typically between mid-March and mid-April.

Despite their adaptable food habits, black bears require extensive areas of diverse habitat types (VDGIF 2013). Although they are often considered a wilderness species, black bears can thrive in areas where forested habitats are interspersed among other land uses. Black bears are often found in large, contiguous tracts of forested lands, and smaller blocks of forested habitat that are linked by forested corridors. Based on known

and apparently viable black bear populations within the southeast, the observed minimum areas that support bear populations are at least 79,000 acres for forested wetlands, and 198,000 acres for forested uplands (VDGIF 2013). Land-use changes that create isolated populations through fragmentation of black bear habitats have serious implications for population viability. Roads with heavy traffic volumes have been shown to limit bear movements (VDGIF 2013). Bear movements that are restricted by heavily used roads may interrupt habitat linkages and contribute to fragmentation concerns.

FOREST TRENDS

With extensive forested areas and a variety of habitat types in all ecoregions, most of Virginia and eastern West Virginia can be considered potential bear habitat (VDGIF 2013; WVDNR 2013). The black bears in western Virginia and eastern West Virginia belong to the largest contiguous bear population in the southeast and mid-Atlantic. Bear population status on the GWNF is monitored by the state agencies of Virginia and West Virginia and uses a combination of indices derived from harvest, age structure, nuisance activity, and miscellaneous mortalities (VDGIF 2013; WVDNR 2013). These indices, coupled with computer modeling, provide a current statewide population estimate of 16,000-17,000 bears in Virginia and 10,000-12,000 in West Virginia. While monitoring indices may provide rough estimates of bear population size, their primary values are to reflect population trends and relative densities. Multi-year harvest trends for both states have indicated significant increases since 1974. Since 2001, trends in harvest and population modeling suggest that the bear population throughout the area encompassing the GWNF has been increasing at about 9% annually (VDGIF 2013; WVDNR 2013).

DIRECT AND INDIRECT EFFECTS

The four activities that have the greatest influence on black bear habitat quality are early successional forest created by timber management, open woodland habitat restored and maintained through prescribed fire, grassland/shrubland restoration and maintenance, and mid- to late- successional hard mast producing forest with an abundance of cavities and den trees.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for black bear. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees

species for black bear and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for black bear. In addition, open woodland habitat is restored at a larger scale than early successional forest habitat.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

Mid- to late – successional hard mast producing forest. The GWNF currently has about 937,800 acres (89%) of mid- to late-successional forest containing hard mast producing trees. Forest types include Cove Forest, Oak Forests and Woodlands, and Pine Forests and Woodlands. The alternative with the highest projections for mid- to late successional hard mast producing forest is C with 951,300 acres (90%) at 10 years. Alternative D has the lowest objective with 908,300 acres (86%) at 10 years. All alternatives have projected mid- to late successional forest of at least 6% or greater on the GWNF, with the difference between the lowest and highest acreage only four percentage points. All alternatives have an abundance of mature hard mast producing forest to provide hard mast and cavities and den trees for black bears (VDGIF 2009).

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas. Hard mast producing species are generally well distributed across the GWNF, although their success is heavily dependent on weather conditions during spring flowering and drought cycles. Adequate mast crops occur about every 3 to 5 years with heavy crops occurring about every 5 to 8 years (VDGIF 2007). The availability of hard mast producing species is not considered to be a problem with any plan alternative as shown in Tables 3B2-12 and 3B2-13.

Remote habitat free from the regular presence of humans is an important component of bear habitat quality. Prescriptions with remoteness as a desired condition are found in Wilderness and recommended wilderness study areas (1A, 1B), Special Biological Areas (4D), Mount Pleasant National Scenic Area (4F), Recommended National Scenic Area (4FA), Shenandoah Mtn Crest–Cow Knob Salamander (8E7), Black Bear/Remote Habitats (8C), and Remote Backcountry (12D), and Mosaics of Habitat–Unsuitable (13U). Currently, 43% of the GWNF is in prescriptions with remoteness as a desired condition. The alternative with the highest percentage of the forest in remote conditions is C (838,698 acres, 79%), followed by Alternatives F, D, A, E, G, H and I [601,645 (56%), 494,291 (46%), 454,194 (43%), 443,771 (42%), and 421,586 (40%) acres, respectively]. The alternative with the lowest percentage of forest in remote conditions is B (361,267 acres, 33%). All alternatives except B have 40% or greater of the GWNF in prescriptions with remoteness as a desired condition.

In summary, the combination of habitat components important for black bear habitat are projected to steadily increase (combination of early forest, open woodlands, and grasslands/shrublands) under Alternatives B, D, E, F, G, H and I, increase only slightly above current conditions under Alternative A, and decrease under

Alternative C. Mid- to late successional mast producing forest is projected to be stable over the next 10 years under all alternatives. Percentage of forest with remote conditions as a desired condition is 40% or greater in all alternatives except B. Given the current increasing population trend for black bears on the GWNF, black bear populations should continue to increase under all alternatives over the next decade.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for black bear. The amount of early successional forest, grassland/shrublands, and mid- to late successional hard mast producing forest acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory, including black bear. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for black bear at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Percentage of forest with remote conditions as a desired condition is 40% or greater in all alternatives except B and not expected to change between year 10 and 50. Long-term black bear populations are projected to continue to increase or stabilized due to factors other than habitat availability (territoriality and/or other population density pressures), under all alternatives.

Northern Bobwhite

AFFECTED ENVIRONMENT

Northern bobwhite (*Colinus virginianus*) numbers have declined steadily throughout their range for over 40 years and quite likely for much longer. From 1980 to 1999, fall bobwhite populations declined 66% and projected trends indicate a further decline of approximately 54% over the next two decades (Dimmick et al. 2002).

A lack of nesting and brood-rearing cover is considered the major limiting factor over much of the range of the northern bobwhite (Dimmick et al. 2002; VDGIF 2009). The loss of native warm season plant communities by planting non-native invasive grasses, planting dense pine forests, and intensive production of row crops is principally responsible for limiting bobwhite populations as well as those of other species such as loggerhead shrike, dickcissel, bobolink, Henslow’s sparrow, Bachman’s sparrow, and field sparrow. Managed warm season grasses with an adequate component of forbs provide good to excellent nesting and brood-rearing habitat. Hardwood forests provide important winter habitats for bobwhite throughout much of its range. Open woodland restoration and management provides habitat conditions that promote bobwhite productivity and survival.

Northern bobwhite has specific seasonal needs that vary throughout the year. This species favors old fields and brushy areas such as wood margins, hedgerows, thickets and open woodlands (Hamel 1992). Summer nesting cover and summer brood habitat consisting of grassy areas (preferably bunch grasses) and weedy patches with exposed bare ground are needed to provide for the recruitment within a population. Winter food and winter cover of seed producing plants and shrublands are needed to carry populations through the dormant season (Rosene 1985). Habitat conditions for bobwhite quail require disturbances from prescribed burning and/or mowing or discing on 2 to 3 year intervals. Northern bobwhite are considered area sensitive in their habitat needs, requiring a landscape patch of 500 acres or greater of interspersed suitable habitat in order to persist over time (Dimmick et al. 2002; VDGIF 2009)

The recovery of bobwhite quail may be difficult with an accelerating loss of available land to create and maintain quail habitat throughout its range. Restoring bobwhite populations range-wide will depend upon: 1) the amount of agricultural lands that are enhanced to provide nesting, brood rearing, and roosting habitats for quail and other grassland species; 2) the amount of pine dominated and mixed pine hardwood lands that are managed to provide open grass- and forb-dominated ground cover through thinning, harvesting, and periodic burning; and 3) the amount of rangeland that is managed to improve native plant communities and provide quail food and cover.

FOREST TRENDS

Populations of bobwhite quail on the GWNF and surrounding landscape are very low, with small and widely scattered areas of occupied range. The population level is presently considered unhuntable, given their low numbers (Puckett VDGIF, personal comm. 2013).

DIRECT AND INDIRECT EFFECTS

Habitat needs for northern bobwhite were considered by reviewing and incorporating elements of the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002) and the Quail Action Plan for Virginia (VDGIF 2009). Habitat conditions recommended to improved conditions for quail include restoration of open woodlands, grasslands/shrublands, and creation of early successional forests.

The three activities that have the greatest influence on bobwhite quail habitat quality are early successional forest created by timber management and other disturbance regimes, open woodland habitat restored and maintained through prescribed fire, and grassland/shrubland restoration and maintenance.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving bobwhite quail habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (VDGIF 2009). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, can provide high quality year-round food and cover for bobwhite quail. Open woodland conditions allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees species for bobwhite quail and many other high priority species. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for bobwhite quail. In

addition, open woodland habitat is restored at a larger scale than early successional forest habitat, usually 500 to 1,000 acres in size and greater.

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands. (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

In summary, the combination of habitat components important for bobwhite quail habitat are projected to steadily increase above current conditions (combination of early forest, open woodlands, and grasslands/shrublands) over the next 10 years under Alternatives B, D, E, F, G, H and I. The combination of early forest, open woodlands, and grasslands/shrublands under Alternative A are projected to increase only slightly above current conditions and decrease under Alternative C. The greatest hope for reversing the declining trends of bobwhite quail is open woodland restoration at a scale of 500 acres or greater, in combination with early successional forest and grassland/shrubland management. Wild bobwhite quail coveys were recently found in a 1,000 acre open woodland patch created and maintained by prescribed fire called Second Mountain (Croy, personal comm. 2010). This is the first documented case of bobwhite quail colonizing open woodland habitat created by prescribed fire on the GWNF. Under all alternatives except A and C, increasing suitable habitat will provide greater opportunity for the northern bobwhite population to increase in the next decade.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for northern bobwhite quail. The amount of early successional forest, and grassland/shrubland acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for northern bobwhite quail at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term bobwhite quail populations have the greatest chance to increase under Alternatives B, E, F, G, H, I and D. Long-

term quail populations have very little chance of increasing due to low availability of suitable habitat, under Alternatives A and C.

American Woodcock

AFFECTED ENVIRONMENT

The American woodcock (*Scolopax minor)* is a migratory shorebird that has adapted to forested habitats. Its distinctive features include stocky body, camouflage feather coloration and a long prehensile bill used to probe moist soils for earthworms, its primary food (WMI 2008). American woodcock populations have steadily decreased over the last 25 years, at a rate of 1-2% per year (Krementz and Jackson 1999; WMI 2008). The general population decline has been attributed to loss of young forest and moist shrubland areas in the eastern and central United States, largely due to human development and changing forestry management practices (WMI 2008). In the Appalachians, breeding populations are highly variable in density and spotty in distribution (WMI 2008). Wintering population densities vary from year to year, but the species is much more common and widely distributed in winter than in summer in the South. According to conservation status rankings, the woodcock is listed as a priority species under the Forest Service's southern national forest migratory and resident landbird conservation strategy (Gaines and Morris 1996).

The American woodcock is closely associated with young, second-growth hardwoods and other early successional habitats that are a result of periodic forest disturbance (Straw et al. 1994; WMI 2008). Ideal habitat consists of young forests and grasslands/shrublands mixed with forested land (Keppie and Whiting 1994). These include forest openings, grasslands, or open woodlands for singing displays in spring, shrubby thickets or other young hardwoods on moist soils for feeding and daytime cover, early successional hardwoods for nesting, and grasslands/open woodlands for night-time roosts (Mendall and Aldous 1943; Andrle and Carroll 1988; Boothe and Parker 2000; WMI 2008). Rich moist habitats adjacent to second order and higher streams and other waterbodies characterized by low gradient, slow flowing, and flat topography are important foraging habitats for American woodcock. American woodcock are considered area sensitive, needing a landscape patch of 500 acres or greater of suitable interspersion of habitat mosaics in order to persist over time (WMI 2008).

Roosting and display habitat is typically open fields, open woodlands, and/or regenerating forests. Woodcock often leave diurnal feeding areas at dusk and fly to openings such as early successional woody patches, log landings, grassy openings, old field areas, and open woodlands. Use of roosting fields begins generally in July and continues to migration. In the Appalachians, roosting areas are used for protection from predators at night. The structure of roosting habitats needs to be open enough for woodcock to detect ground predators while affording scattered overhead protection from avian predators (WMI 2008). Maintenance of old fields for roosting and display habitat can be accomplished through disking, mowing, use of herbicides, and prescribed burns, although maintaining some small trees and shrubs is desirable. The goal is to create open habitats that are "patchy," rather than uniform in structure (Krementz and Jackson 1999).

Natural disturbances historically responsible for creation of early successional habitat also improve woodcock habitat. Beavers created extensive habitat, as did fire and possibly windstorms. In general, maintaining integrity of wetter sites such as springs, streams and creeks is beneficial to these species. Allowing thickets to grow in riparian areas will greatly improve habitat quality for woodcock, (Krementz and Jackson 1999). Grassy areas and open woodlands near water provide prime nesting and display grounds. Restoration of beavers on the GWNF would increase suitable foraging habitat.

Non-breeding, migrating and/or wintering habitat is similar to breeding habitat but includes more open conditions such as sedge meadows, beaver pond margins, rice fields, upper reaches of estuaries and occasionally coastal meadows (del Hoyo et al. 1996). Winter habitats range from bottomland hardwoods to upland pine forests, young pine plantations, and mature pine-hardwood forests, though in some pine habitats the birds tend to focus their activities in lowlands dominated by hardwoods (Roberts 1993). Unlike during breeding, mature pine-hardwood and bottomland hardwoods are often preferred (Krementz and Pendleton 1994; Horton and Causey 1979). During the non-breeding season, woodcock generally occupy moist thickets

in daytime, and shift to more open habitats such as pastures, fields (including agricultural), open woodlands, and young woody vegetation at night. A diversity of habitat types and age classes may be especially important to survival when severe weather forces woodcock from preferred sites (Krementz and Pendleton 1994). The use of prescribed burns is a common forest management practice and can be used to set back plant succession. A light, controlled fire can maintain habitat patchiness as well. Burns may also remove pine needle cover, opening the ground to woodcock foraging and roosting. Mowing can also be used to improve foraging habitat, but appropriate habitat should be maintained for nesting birds (Roberts 1993).

FOREST TRENDS

Most woodcock use the GWNF during migration periods, but breeding woodcock have been confirmed on the GWNF. Populations of woodcock appear very low and scattered on the forest (Norman VDIGF, personal comm. 2013).

DIRECT AND INDIRECT EFFECTS

The three activities that have the greatest influence on American woodcock habitat quality are early successional forest created by timber management for nesting and foraging if near riparian areas, open woodlands created and maintained through prescribed fire for singing grounds and evening roost areas, and grassland/shrubland restoration and maintenance for singing/roosting grounds, and nesting/foraging if near riparian areas.

Early successional forest. The GWNF currently has about 13,600 acres of early successional habitat created by timber management (1%), and an additional estimated 16,900 acres from unplanned disturbance events such as gypsy moth mortality, southern pine bark beetle mortality, hemlock wooly adelgid, ice storm damage, and severe wild fires (2%). The highest projected acreage of early successional forest created by timber management is 30,000 – 50,000 acres (3-5%) at 10 years under Alternative D (Table 3B2-12). The lowest is Alternative F with 10,000 – 18,000 acres (1-2%) at 10 years. Alternatives A, B, E, G, H and I have similar timber management objectives [18,000 – 30,000 acres (2-3%)] at 10 years. Alternative C, which assumes no timber harvesting, has 16,900 acres (2%) of early successional forest at 10 years resulting from natural disturbances only and cannot be planned. All other alternatives also project an additional 16,900 acres (2%) of early successional habitat from natural disturbance events such as wild fires, ice storms, blowdowns, and overstory mortality associated with insects and diseases such as gypsy moth and hemlock wooly adelgid. While it cannot be planned when and where it occurs on the GWNF, this level of mortality was estimated from GIS analysis of the previous 10 years of disturbance events and is reasonable to assume will continue for the next 10 years.

Open woodland restoration. The GWNF currently has about 22,500 acres of open woodland created by prescribed fire, and an additional 19,800 acres created by unplanned disturbance events. The highest projected acreage of open woodland created by prescribed fire is 99,000 acres (9%) at 10 years under Alternative E (Table 3B2-12). The lowest is 6,100 acres under Alternative C. Alternatives B, F, G, H and I have similar fire management objectives (64,500-99,000 acres at 10 years, 6-9%). Alternatives D and A have lower fire management objectives (43,900-64,500 and 35,900 acres at 10 years, respectively). Open woodlands from natural disturbance events are estimated to be an additional 19,800 acres under all alternatives (2%). The success of prescribed fire in improving American woodcock habitat depends on many factors, including site quality, stand conditions, and fire prescriptions (WMI 2008). Prescribed fire that restores open woodland structural conditions (in appropriate forest types) in an otherwise closed canopy forested landscape, allows the development of woody browse, grasses, forbs, and soft and hard mast producing shrubs in the understory, while maintaining an overstory of hard- and soft- mast producing trees. Such habitat is favorable for singing grounds and evening roost areas for American woodcock. While early successional forest is ephemeral, changing locations over time across the GWNF, open woodlands, when maintained by fire, creates permanent habitat for American woodcock. Prescribed fire, especially when applied over large areas, feathers into more mesic sites. The lighter fire effects can create shrubby conditions in moist soil areas, creating suitable foraging areas for woodcock (WMI 2008).

Grassland/shrubland restoration and maintenance. The GWNF currently has about 4,300 acres in maintained grasslands/shrublands (Table 3B2-12). Alternatives B, E, F, G, H and I have the highest objectives for grassland/shrubland restoration and maintenance of 6,700 acres at 10 years. Alternative C has the lowest objective at 3,400 at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with up to 135,700 acres (13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,500 acres (1%) at 10 years.

The alternatives with the highest combination of projected early successional forest habitat, open woodlands, and grassland/shrublands from active management activities are B, E, G, H and I with 89,200 to 135,700 acres (8-13%) at 10 years. The alternative with the lowest combination early forest, open woodlands, and grassland/shrublands is Alternative C with 9,545 acres (1%) at 10 years.

Under Alternatives A and D, most early successional woody habitat created by timber management would be developed in the 8A1, 8B, 8C, and 10B management prescription areas, comprising 43% and 54% of the total forested acreage of the GWNF, respectively. Under Alternatives B, E, F, G, H and I, most early successional woody habitat created by timber management would be developed in the 13 management prescription area, comprising 54%, 46%, 33%, and 48% of the total forested acreage, respectively. Prescribed burning and grassland/shrubland restoration and maintenance is a suitable use not only in the aforementioned management prescription areas, but in all other prescription areas except 1A Designated Wilderness, representing 96% of the total forested acreage. Therefore open woodland and grassland/shrubland restoration/maintenance can be accomplished, where appropriate, over most of the GWNF landscape. Active management prescription areas and suitable active management activities are well distributed over the GWNF landscape, with the exception of wilderness areas.

The availability of early successional woody habitat, grasslands/shrublands, and open woodlands (especially near riparian areas) for nesting, singing grounds, diurnal feeding, and evening roosting, is the most limiting factor to American woodcock populations on the GWNF and the Appalachian region in general (WMI 2008). The combination of habitat components important for woodcock are projected to steadily increase above current conditions (combination of early forest, open woodlands, and grasslands/shrublands) under Alternatives B, D, E, F, G, H and I increase only slightly under Alternative A, and decrease under Alternative C over the next 10 years. American woodcock populations have the greatest chance to increase under Alternatives B, D, E, F, G, H and I. Woodcock populations are projected to stabilize or decrease under Alternatives A and C, due to low availability of suitable habitat components.

CUMULATIVE EFFECTS

Table 3B2-13 displays the projected habitat components at year 50, by alternative, that have the greatest influence on habitat quality for northern bobwhite quail. The amount of early successional forest and grassland/shrubland acres stay relatively constant from 10 year to 50 years under each alternative. The largest difference is the increase in open woodland habitat for some alternatives, increasing to about 170,600 acres (16%) at year 50 under Alternatives B, E, F, G, H and I, 108,700 acres (10%) under Alternative D, and 42,700 acres (4%) under Alternative A. Open woodland habitat increases to 12,200 acres (1%) between years 10 to 50 under Alternative C. Open woodland structural conditions do not affect the age of the overstory trees, therefore preserving the mid- to late successional age structure of the forest. The largest difference is in the understory, because the overstory trees are spaced far enough apart to allow sunlight to reach the forest floor. Many high priority species need both mature overstory trees and a dense grassy/shrubby/herbaceous understory. When combining early successional forest, grassland/shrubland, and open woodland restoration, Alternatives B, E, F, G, H and I project a cumulative increase in the acreage of habitat important for American woodcock at year 50 up to 208,700 acres (20%.) Alternatives D and A also projects a cumulative increase, but at a lower rate. Alternative C projects no increase in these habitat components. Long-term American woodcock populations have the greatest chance to stabilize and/or increase under Alternatives B, D, E, F, G, H and I.

Long-term American woodcock populations should be expected to stabilize and/or decrease due to low availability of suitable habitat under Alternatives A and C.

B2D – MIGRATORY SPECIES

AFFECTED ENVIRONMENT

Migratory birds have become a focus of conservation concern due to evidence of declining population trends for many species. To ensure that forest plan revision alternatives include provisions for migratory bird habitat, planning efforts included coordination with the Migratory Bird Office of the U.S. Fish and Wildlife Service and others under the umbrella of Partners in Flight (PIF) and the Appalachian Mountains Joint Venture (AMJV). Both PIF and AJV are cooperative efforts involving partnerships among federal, state, and local government agencies, foundations, professional organizations, conservation groups, industry, the academic community and private individuals. They were launched in response to growing concerns about declines in populations of all bird species and to emphasize conservation of birds not covered by existing conservation initiatives.

PIF and AJV have developed Bird Conservation Plans for each physiographic area relevant to the national forest planning area. These plans are science-based, long-term, proactive strategies for bird conservation across all land ownerships and are designed to ensure long-term maintenance of healthy populations of native land birds. Forest Service biologists work with PIF and AJV coordinators to identify key management issues and opportunities for high priority species on National Forest System lands, and developed related goals, objectives, and standards for incorporation into the Revised Forest Plan. In addition, *The Southern National Forest's Migratory and Resident Landbird Conservation Strategy* (Gaines and Morris 1996) was also reviewed and incorporated into planning efforts. This strategy identifies priority species and provides a framework for monitoring populations. The monitoring program described in this document is currently being implemented, and would continue under all alternatives.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Because migratory and resident landbirds are widespread and diverse, they are relevant to the majority of ecological communities and habitat elements considered during forest planning. As a result, provisions for these species are integrated into numerous plan objectives and standards focused on achieving desired habitat conditions. Effects of each alternative on ecological communities, associated species, and all relevant conservation priority species (as identified by the U.S. Fish and Wildlife Service) are addressed in the Ecological Diversity Analysis in the EIS (See Ecosystem Diversity and Species Diversity Sections, Chapter 3B 1 & 2) Effects to specific species of birds are addressed under appropriate sections for those chosen as Management Indicator Species (MIS).

The majority of the George Washington National Forest is contained within the Ridge and Valley Ecological Region, but there are also sections contained within the Blue Ridge and Allegheny Mountain Ecological Regions. The PIF plans and associated management issues for each of these areas will be addressed at some level in the Forest Plan Revision. Key landbird conservation issues within these Regions are summarized below.

- Creation and maintenance of early succession grassland/shrubland habitat is desirable in order to provide habitat for high priority species such as the golden-winged warbler, prairie warbler, mourning warbler and whip-poor-will. There are several management objectives that identify the need to provide large enough patches of early successional habitat for area-sensitive early successional species In addition, an objective to create or maintain at least 285 acres of high elevation early successional habitat through forest regeneration and/or maintenance of balds, utility rights of way, old fields, and open woodlands (See Ecological and Species Diversity Reports).
- Creation of structural diversity in mature stands to enhance conditions desirable for species such as the cerulean warbler, worm-eating warbler, and wood thrush. Mesic oak and mixed mesophytic

stands can be evaluated for addition of canopy gaps and vertical structure through group selection and commercial thinning harvest programs.

- Conservation and restoration of spruce-fir and northern hardwood forest communities are important for associated boreal bird species. Spruce-fir forests are treated as rare communities in the George Washington National Forest Plan and they will be maintained and restored across all alternatives. Standards protect the spruce-fir type from conversion to other forest types and from silvicultural practices except those designed to maintain or restore the type in all alternatives.

In addition to providing a diversity of habitats for migratory birds on the landscape, collision of migratory birds with communications towers was considered during plan revision. Two mechanisms for bird mortality occur at communications towers (FWS 2005). Many bird species are nocturnal migrants. Birds flying in poor visibility conditions (cloud cover and fog) may not see communication structures or supporting guy wires (i.e., blind collision). Towers that are lighted at night for aviation safety may help reduce blind collisions, but can cause a second potential mechanism for mortality in low cloud ceiling or foggy conditions. Refracted light creates an illuminated area around the tower. Migrating birds lose their stellar cues for nocturnal migration and a broad orienting perspective on the landscape in these weather conditions. The lighted area may be the strongest cue for navigation, and birds remain in the lighted space by the tower. Mortality occurs when they collide with the structure and guy wires, or even other migrating birds. The GWNF Plan adopts forestwide standards requiring removal of obsolete communications towers, location of new communication equipment on existing towers where possible, and coordination of new tower planning and construction with U.S. Fish and Wildlife Service in an effort to reduce tower collision mortality and to comply with the Migratory Bird Treaty Act, the Endangered Species Act, and the Bald and Golden Eagle Act.

B2E – MANAGEMENT INDICATOR SPECIES

National Forest Management Act regulations, adopted in 1982, require selection of management indicator species (MIS) during development of forest plans (36 CFR 219.19(a)). Reasons for their selection must be stated. This section describes the MIS selected for the revised Land and Resource Management Plan and the conditions they are to represent. A more complete documentation of the process is contained in the MIS Process Selection paper in the administrative record.

Management indicator species (MIS) are to be selected “because their population changes are believed to indicate the effects of management activities” (36 CFR 219 (a)(1)). They are to be used during planning to help compare effects of alternatives (36 CFR 219.19(a)(2)), and as a focus for monitoring (36 CFR 219.19(a)(6)). Where appropriate, MIS shall represent the following groups of species (36 CFR 219 (a)(1)):

- Threatened and endangered species on State and Federal lists;
- Species with special habitat needs;
- Species commonly hunted, fished, or trapped;
- Non-game species of special interest; and
- Species selected to indicate effects on other species of selected major biological communities.

Since adoption of these regulations, the management indicator species concept has been reviewed and critiqued by the scientific community (Caro and O’Doherty 1999; Simberloff 1998; Noss 1990; Landres et al. 1988; and Weaver 1995). These reviews identify proper uses and limitations of the indicator species concept. They generally caution against overreaching in use of indicator species, especially when making inferences about ecological conditions or status of other species within a community. Caution is needed because many different factors may affect populations of each species within a community, and each species’ ecological niche within a community is unique.

To reflect this current scientific understanding while meeting the letter and spirit of regulations, we have made great effort to clearly define the legitimate uses and limitations of each selected MIS. The MIS process is but

one tool used to develop management strategies and monitoring programs designed to meet NFMA requirements related to diversity of plant and animal communities. Other elements used for comprehensive planning for plant and animal diversity include: objectives and standards for maintenance and restoration of desired ecological conditions based on knowledge of overall ecosystem structure and function; biological evaluations and assessments at both the forest plan and site-specific project levels; and evaluation of risk to species of viability concern at the forest plan level. Other elements important to monitoring effects of plan implementation on plant and animal diversity include, where appropriate, monitoring of key ecological conditions, levels of management activities important to restoration and maintenance of community diversity, species assemblages (birds, bats, fish, etc.), harvest levels of game and other demand species, and populations of threatened, endangered, and sensitive species.

Table 3B2-15. MIS for the GWNF

Species Common Name	Category (s)
Cow Knob Salamander	T/E/S Indicator, Special Interest Species Indicator
Pileated Woodpecker	Special Habitat Indicator
Ovenbird	Special Habitat Indicator
Chestnut-sided Warbler	Special Habitat Indicator
Acadian Flycatcher	Special Habitat Indicator
Hooded Warbler	Biological Community Indicator
Scarlet Tanager	Biological Community Indicator
Pine Warbler	Biological Community Indicator
Eastern Towhee	Biological Community Indicator
Wild Brook Trout	Biological Community Indicator, Demand Species
Eastern Wild Turkey	Demand Species Indicator
Black Bear	Demand Species Indicator
Deer	Demand Species Indicator
Beaver	Riparian Ecological System Indicator

AFFECTED ENVIRONMENT

Cow Knob Salamander

This salamander (*Plethodon punctatus*) is a species with a restricted range. It is endemic to the higher elevations of Shenandoah Mountain along the VA/WV border. It is a terrestrial salamander that occurs primarily above 2500 feet in elevation and mainly occurs in rocky talus areas on north to northeast aspects. It forages openly on cool to warm, dark, humid/rainy nights consuming small insects and other invertebrates. The Cow Knob salamander is an MIS because it is a Sensitive species and a narrow endemic that occurs almost entirely on the George Washington National Forest (North River Ranger District).

FOREST TRENDS

As documented in Appendix G of the 2004 Monitoring and Evaluation report, the habitat trend is one of an aging forest that benefits Cow Knob salamanders and should lead to a stable or increasing population. Recent

field surveys (2002-2003) discovered the Cow Knob salamander outside the current range south along Shenandoah Mountain to Hardscrabble Knob.

Table 3B2-16. Cow Knob Salamander Population Surveys

Location	Year of Survey	# of Adults	# of Juveniles	Total #
Sugar Grove, VA	2005	14	20	34
Sugar Grove, VA	2006	17	27	44
Sugar Grove, VA	2007	27	27	54
Tomahawk, WV	2004	1	9	10
Tomahawk, WV	2006	1	2	3

Pileated Woodpecker

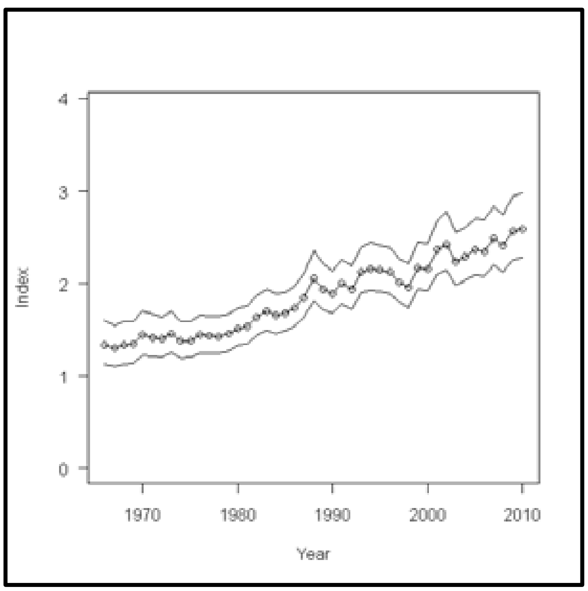
The pileated woodpecker (*Dryocopus pileatus*) was selected as an MIS because it requires large snags for nesting and feeding. The occurrence of this species may be correlated with forested habitats containing abundant large dead trees and fallen logs (Hamel 1992), which also are used by other birds, mammals, and amphibians. This species is selected to help indicate the effects of management activities on the availability of forests with desired abundance of snags. Population monitoring would be combined with information on forest age-class distribution and snag densities to provide a full picture of management effects on this species and other snag-dependent wildlife.

FOREST TRENDS

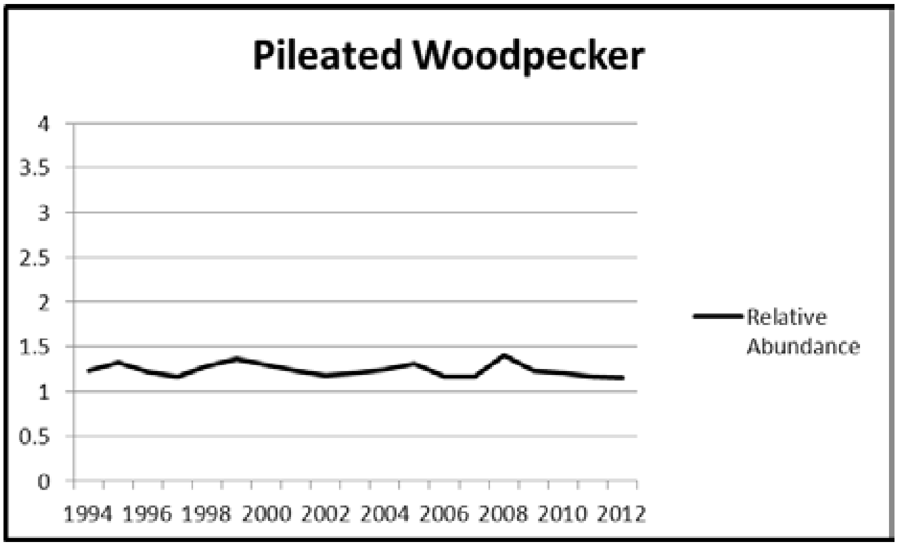
USGS Breeding Bird Survey (BBS) data indicates an increasing population trend of pileated woodpeckers in the Appalachian Region. USFS avian point count data from the GWJNFs indicate an overall stable population trend.

Trend in BBS Data of Pileated Woodpeckers across the Appalachian Region, 1966 To 2010.

Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Pileated Woodpeckers across the GWJNF, 1994 to 2012
Source: Southern Region Avian Monitoring Database



Pileated woodpeckers generally prefer mature forests near riparian areas. This species is a primary cavity nester/excavator, requiring large snags for nesting cavities and large dead trees for feeding. Generally, this species requires trees greater than 15 inches dbh for cavities, but prefers trees greater than 20 inches dbh. Based on the results of monitoring data, this species is showing stable population trends on the GWJNFs and increasing trends across the Appalachian Region. Pileated woodpeckers have the abundance and distribution across the Forest that will provide for its persistence into the foreseeable future.

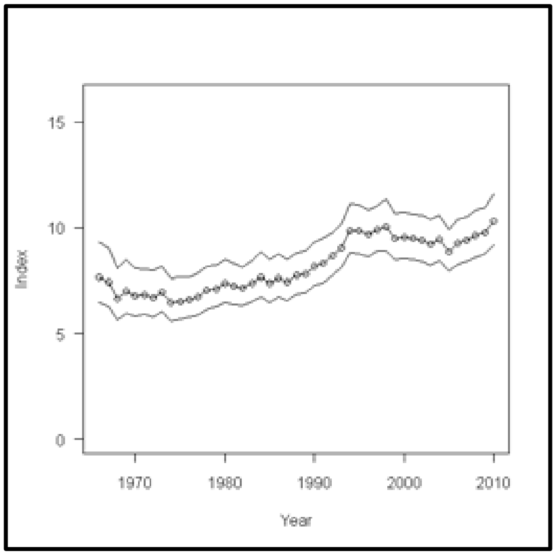
Ovenbird

The ovenbird *(Seiurus aurocapillus)* was selected as a MIS because it is associated with mid-successional to mature forest interior habitats (Hamel 1992; Crawford et al. 1981). This species is selected to help indicate the effects of management on the availability of suitable mature forest interior habitats. Other elements, such as landscape analysis of forest fragmentation using remote sensing data, would supplement information received from monitoring this species.

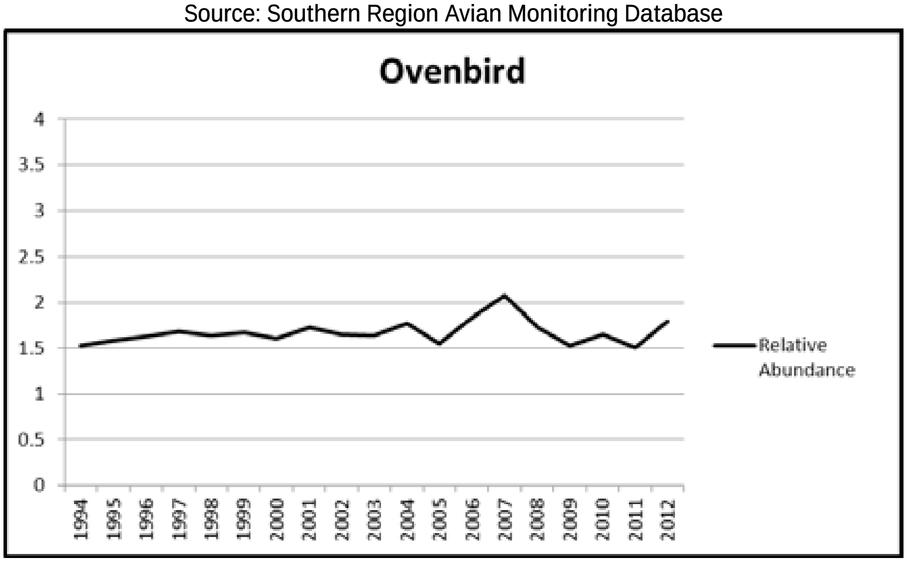
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable to increasing trends in the Appalachian region. USFS Avian point count data from the GWJNFs for ovenbird also indicates an overall stable to increasing population trend.

Trend in BBS Data of Ovenbirds across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Ovenbirds across the GWJNF, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Ovenbirds breed in upland deciduous or mixed deciduous/pine forests with a moderately dense understory. They nest on the ground and build a covered nest from leaf litter. They require large patches of mature forest for nesting. While the need for large patches of mature forested habitat has been well documented for many migratory bird species, including ovenbirds, evidence is mounting that early successional woody habitats are also important during the critical time period just after breeding and during migration (Bulluck and Buehler 2006). These areas provide safe havens for adult and fledgling ovenbirds for the following needs: molting, abundant food for the buildup of fat reserves for migration, and protection from predators. Studies strongly recommend conservation strategies that maintain large tracts of mature forest, within which there is a mosaic of different forest types and ages (early and mid-successional forest stands), to provide the habitat requirements needed by migratory birds such as ovenbirds during all of their life stages here in North America. Based on the results of monitoring data, this species exhibits stable to increasing population trends on the

GWNF, as well as region-wide, and have the abundance and distribution across the Forest that will provide for their persistence into the foreseeable future.

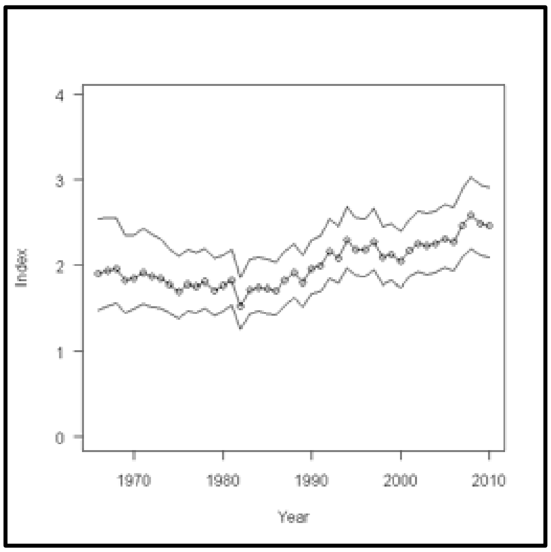
Chestnut-Sided Warbler

The chestnut-sided warbler (Dendroica pensylvanica) was selected as a MIS because of its association with high-elevation early successional habitats. This species is selected to help indicate the effects of management on the availability of higher elevation early successional habitat. Trends for these species will be evaluated along with trends in total acres, age-class distribution, and level of restoration and maintenance activities to provide a more complete picture of effects of management on this community.

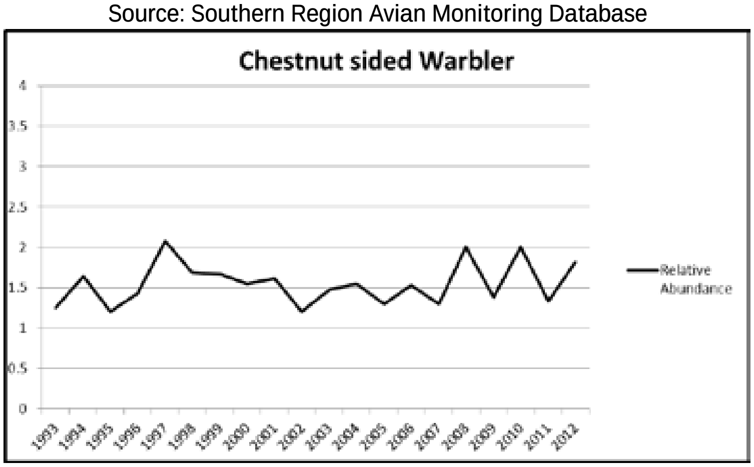
FOREST TRENDS

USGS Breeding Bird Survey data indicates a relatively stable trend in chestnut-sided warblers in the Appalachian region. USFS Avian point count data also indicates an overall stable population trend across the GWJNFs.

Trend in USGS BBS Data of Chestnut-sided warblers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Chestnut-sided warblers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Chestnut-sided warblers are associated with larger patches (e.g. greater than 12 acres) of early successional woodlands, mountain laurel thickets, and forest edge habitat above 2,000 feet (Hamel 1992; Hunter et al. 2001). Chestnut-sided warblers have exhibited significant continental population declines in the last couple of decades, mirroring an overall trend of decline of disturbance-dependent bird species associated with open habitats in eastern North America (Vickery 1992; Askins 2000; Hunter et al. 2001). A significantly greater proportion of bird species exhibiting steep population declines are associated with disturbance-mediated habitats than in forested or generalist habitat types (Brawn et al. 2001). Combined with recent research highlighting the importance of early successional woody habitat for post-breeding and migratory stop-over needs of forest-interior migratory bird species in a larger landscape of mature forest (see sections on ovenbirds, worm-eating warblers, and hooded warblers), the role of early successional habitat in largely mature, forested landscapes and the need to restore/maintain disturbance regimes creating such habitats is of vital importance in conservation planning (Brawn et al. 2001; Hunter et al. 2001). Based on the results of monitoring data, chestnut-sided warblers show a stable population trend on the GWNF, and the Appalachian region, with an abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

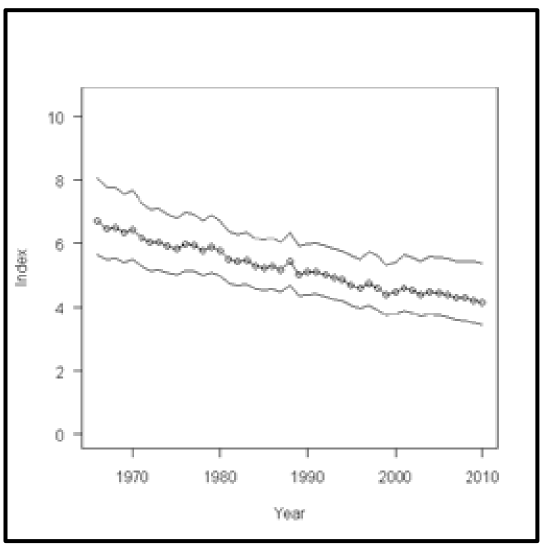
Acadian Flycatcher

The Acadian flycatcher (*Empidonax virescens*) was selected as MIS because of its association with riparian habitat in deciduous and mixed deciduous/coniferous forests. It is highly associated with riparian habitat streams and bottomland hardwoods (Hamel 1992).

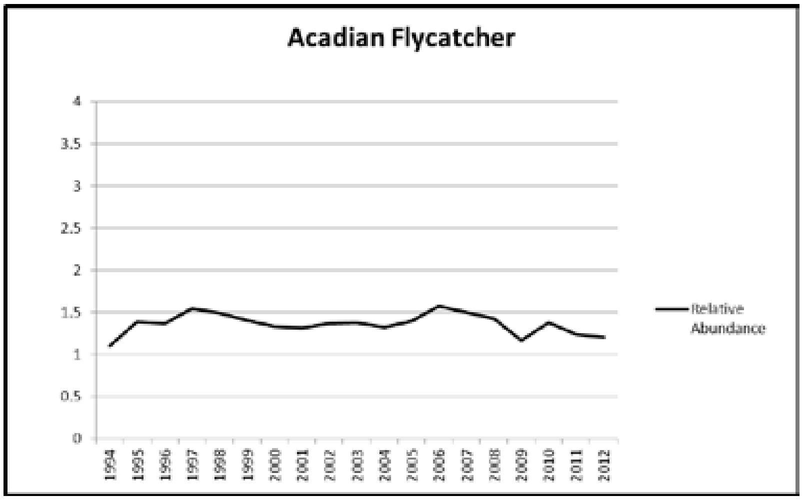
FOREST TRENDS

USGS Breeding Bird Survey data indicates declining trends in the Appalachian region. Data from the GWJNF point count data for the Acadian flycatcher indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Acadian flycatchers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Acadian flycatchers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Acadian flycatchers occur in deciduous, mixed deciduous/coniferous forest types, in riparian areas (Hamel 1992). Acadian flycatchers are often associated with closed overstory canopies and open understories. After breeding, Acadian flycatchers utilize open scrub and early successional woody habitat during migration. With overall stable population trends of Acadian flycatcher on the GWJNFs, Acadian flycatchers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future. Though such trends are not apparent on the GWJNFs, of concern are declining trends shown by USGS BBS data in populations of Acadian flycatcher throughout the larger Appalachian region.

Black Bear, Wild Turkey, and White-Tailed Deer

These species were retained as MIS because they are species of high demand in Virginia. The National Forest provides key habitat attributes for bear in Virginia including remoteness and the availability of den trees and mast. Many Virginia hunters must utilize public lands to pursue deer and turkey, thus management activities will influence their success and experience. The Virginia Department of Game and Inland Fisheries tracks annual harvest for these species; harvest data is identified by county and land ownership status (public versus private). These MIS are discussed under the Demand Species section of this Chapter.

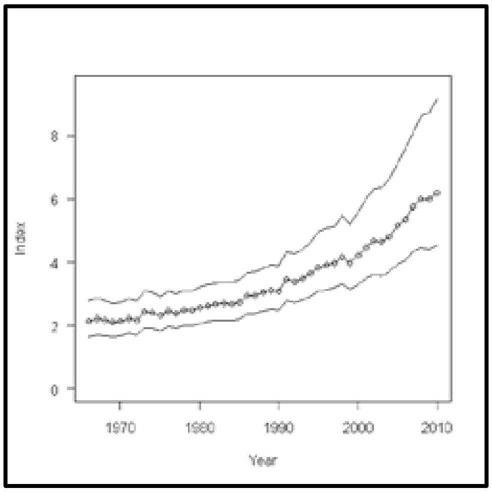
Hooded Warbler

The hooded warbler (*Wilsonia citrina*) was selected as an MIS for mid- to late-successional mesic deciduous forests. The hooded warbler is heavily associated with moist deciduous forests with fairly dense understories, where it breeds and feeds (Hamel 1992; Crawford et al. 1981). Management opportunities exist to increase the structural diversity of closed canopied habitats in this type to favor species, such as the hooded warbler, that optimize their life history in forests with canopy gaps and patches of dense understory. This species is expected to respond positively to management actions (including thinning and moderate frequency burning) that are designed to stimulate advanced oak regeneration and perpetuation of the forest type on these mesic sites. This species is deemed appropriate for helping to indicate the availability of mid- and late-successional mesic deciduous habitats and the efficiency of management intended to favor its habitat.

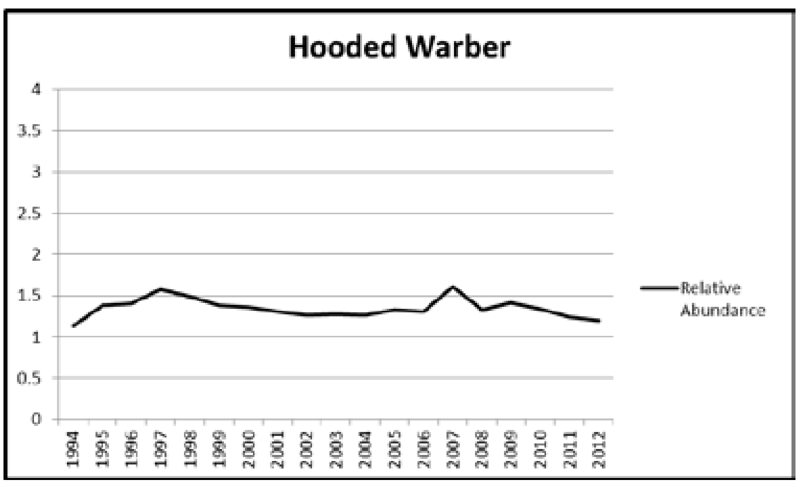
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable to slightly increasing population trends for hooded warbler in the Blue Ridge Mountain and Ridge and Valley regions. Data from the GWJNFs point count data for hooded warbler indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Hooded warblers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Hooded warblers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Hooded warblers occur in deciduous, mixed deciduous/coniferous forest types, near or in riparian areas (Hamel 1992; Robbins et al. 1989). Hooded warblers are associated with canopy gaps and other small patches of dense woody vegetation in an otherwise mature forest (Robbins et al. 1989; Hunter et al. 2001). After breeding, both fledglings and adults move to areas characterized by dense, woody vegetation, abundant insect availability, and the presence of ripe fruits (Morton 1990; Evans Odgden and Stutchbury 1997; Anders

et al. 1998; Vega Rivera et al. 1998, 1999). These areas provide safe havens for molting, abundant food for the buildup of fat reserves for migration, and protection from predators. Habitats supporting this kind of vegetation include open oak, oak/pine, and pine woodlands, patches of early successional habitat resulting from insect infestation and natural disturbance such as ice storms, patches of early successional habitat where the overstory had been thinned or harvested in some way (modified shelterwood, clear cut, high-grading), areas of second growth scrub/deciduous saplings located along forest borders and old fields, and mature riparian forests with a dense understory (Anders et al. 1998; Vega Rivera et al. 1998, 1999). Recent studies strongly recommend conservation strategies that maintain large tracts of mature forest, within which there is a mosaic of different forest types and ages (early and mid-successional forest stands), as well as mature riparian forest, to provide the habitat requirements needed by migratory birds during all of their life stages here in North America, including the hooded warbler (Kilgo et al. 1999; Suthers et al. 2000; Hunter et al. 2001). With overall stable population trends of hooded warbler on the GWJNFs and stable to increasing trends at the regional level, hooded warblers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

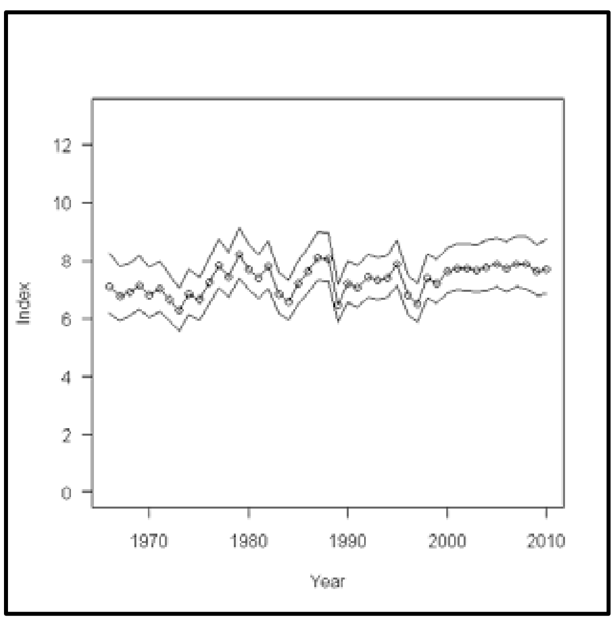
Scarlet Tanager

Drier oak forests support a slightly different mix of species due to their more open woodland condition. To represent this upland oak community, the scarlet tanager (*Piranga olivacea*) is selected as an MIS. This species is most abundant in upland mature forest (Hamel 1992). Trends for these species will be evaluated along with trends in total acres, age-class distribution, and level of restoration and maintenance activities in this forest type to provide a more complete picture of effects of management on this community.

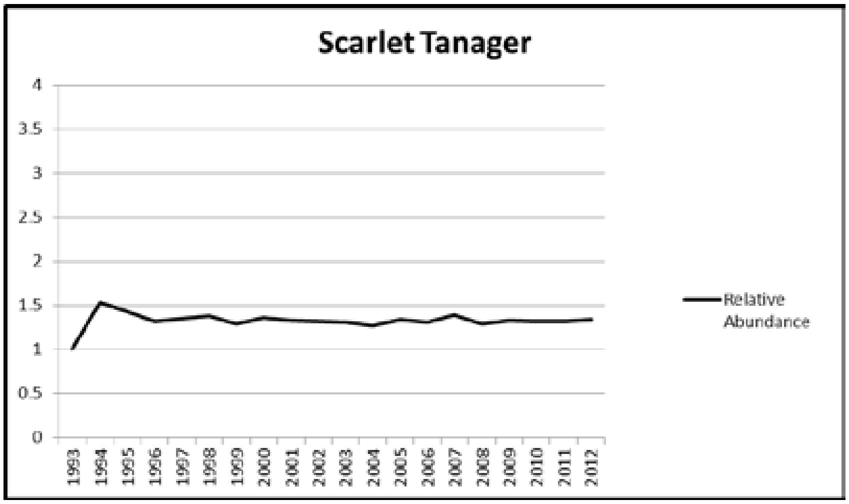
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable to slightly increasing population trends of scarlet tanagers for the Blue Ridge Mountain and increasing population trends in the Ridge and Valley regions. Data from the GWJNFs point count data for scarlet tanager indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Scarlet tanagers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Scarlet tanagers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Scarlet tanagers occur in deciduous, mixed deciduous/coniferous and coniferous forest types in the Appalachian region (Rosenburg et al. 1999). In the Appalachian region, research has indicated that scarlet tanagers do not show area sensitivity in moderately or heavily forested landscapes (Rosenburg et al. 1999). With overall stable to increasing population trends of scarlet tanagers on the GWJNFs and at the regional level, scarlet tanagers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

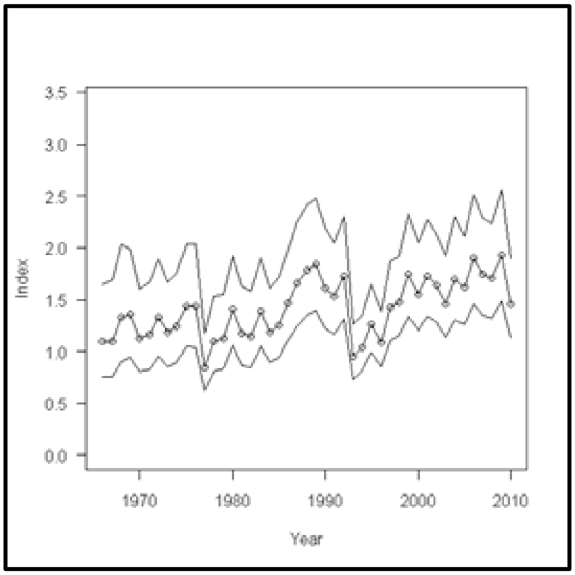
Pine Warbler

Pine forests have been in serious recent decline on the national forest as a result of southern pine beetle epidemics and lack of fire needed to maintain their dominance. Therefore, they will be the focus of ecological restoration and maintenance on some portions of the national forest. The pine warbler (*Dendroica pinus*) is closely associated with pine and pine-oak forests, generally occurring only where some pine component is present. It therefore is an appropriate indicator of the effects of management in restoring and maintaining pine forests. It should be noted, however, that this species does not discriminate as to the condition of pine stands relative to mid and understory, and so would indicate little more than the presence of pine. Other bird species that may be associated with desired fire-maintained conditions were not deemed sufficiently likely to be present to be appropriate MIS. Understory plant species also were considered and found to be too universal in association to be appropriate MIS. Therefore, pine warbler and various habitat-based elements, such as amount and effectiveness of prescribed burning, will be used to indicate effects of management on species associated with this community.

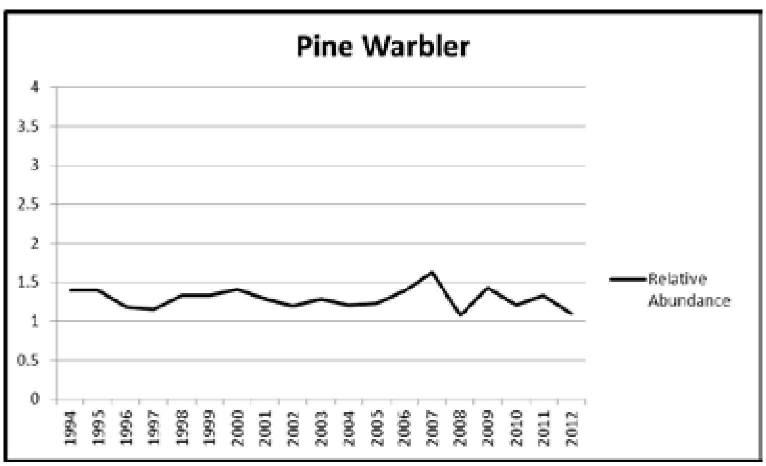
FOREST TRENDS

USGS Breeding Bird Survey data indicates stable population trends of pine warblers for the Blue Ridge Mountain and stable to slightly increasing trends in the Ridge and Valley regions. Data from the GWJNF point count data for pine warbler indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Pine warblers across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Pine warblers across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Pine warblers occur in mid- to late-successional pine and pine/oak forest types throughout its range (Hamel 1992). It is rarely found in pure hardwood forest types. Pine warblers are temperate migrants in the Appalachians, shifting to the Piedmont and Coastal Plain during the winter months. They are mainly insectivorous during the breeding season, but shift to insects, berries, and small seeds the rest of the year. With overall stable population trends of pine warbler on the GWJNFs and stable to increasing trends in the Blue Ridge and Ridge and Valley regions, pine warblers have the abundance and distribution across the Forests that will provide for their persistence into the foreseeable future.

Eastern Towhee

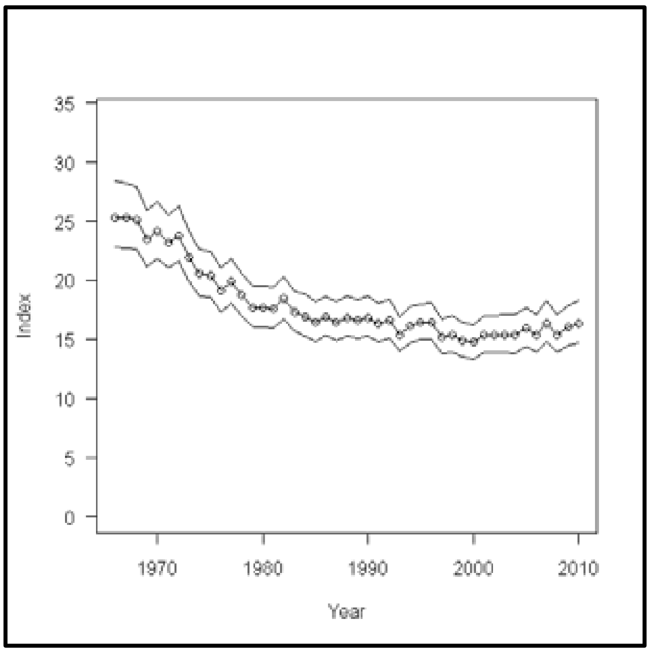
The eastern towhee (*Pipilo erythrophthalmus*) was selected as the most appropriate MIS to represent early successional forests. Eastern towhees are shrubland nesting birds that require thickets or brushy places on

the ground or in shrubs or saplings to 5 feet high for nesting. Providing early successional and open woodland forest is necessary to support populations of this species.

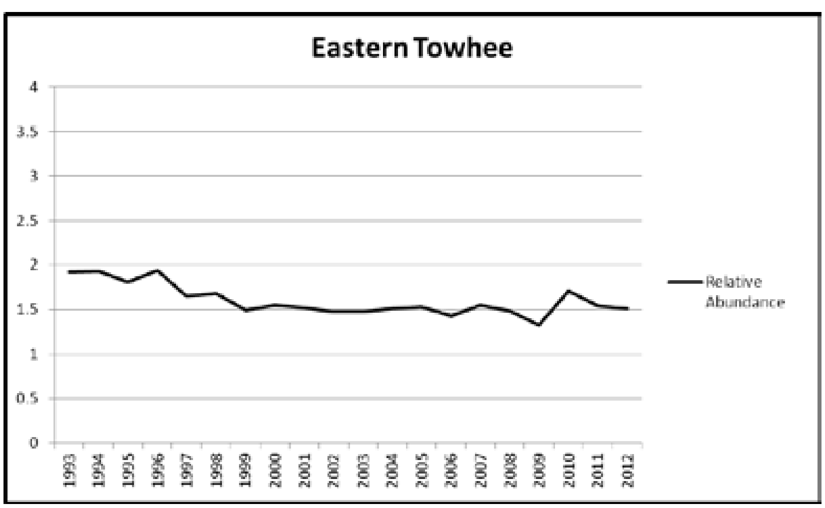
FOREST TRENDS

USGS Breeding Bird Survey data indicates decreasing to stable population trends of eastern towhees for the Blue Ridge Mountain and decreasing trends in the Ridge and Valley regions. Data from the GWJNF point count data for eastern towhee indicate an overall stable trend on the GWJNFs.

Trend in USGS BBS Data of Eastern towhees across the Appalachian region, 1966 To 2010.
Source: http://www.mbr-pwrc.usgs.gov/bbs/bbs.html



Trend in USFS Avian Point Count Data of Eastern towhee across the GWJNFs, 1994 To 2012
Source: Southern Region Avian Monitoring Database



Eastern towhees inhabit early successional habitat associated with dense second growth, dense vegetation associated with open woodlands, and forest edge habitat (Hamel 1992; Hunter et al. 2001). Eastern towhees have exhibited significant continental population declines in the last couple of decades, mirroring an overall trend of decline of disturbance-dependent bird species associated with open habitats in eastern North America (Vickery 1992; Askins 2000; Hunter et al. 2001). A significantly greater proportion of bird species exhibiting steep population declines are associated with disturbance-mediated habitats than in forested or generalist habitat types (Brawn et al. 2001). Forty percent of all North American species associated with some type of disturbance-mediated habitat (grassland, shrub-scrub, open woodlands) have been significantly decreasing in population since 1966 (Brawn et al. 2001). Combined with recent research highlighting the importance of early successional woody habitat for post-breeding and migratory stop-over needs of forest-interior migratory bird species in a larger landscape of mature forest (see sections on ovenbirds and worm-eating warblers and hooded warblers), the role of early successional habitat in largely mature, forested landscapes and the need to restore/maintain disturbance regimes creating such habitats is of vital importance in conservation planning (Brawn et al. 2001; Hunter et al. 2001). With overall stable population trends of eastern towhees on the GWNF, and in the Blue Ridge region, eastern towhees have an abundance and distribution across the Forests that will provide for their persistence into the foreseeable future, though the steadily declining trends in the Ridge and Valley region are cause for concern.

Wild Brook Trout

Wild brook trout (*Salvelinus fontinalus*) were chosen as a MIS because many of the trout streams on the GW National Forest support wild native brook trout. Wild trout are indicative of cold water streams, good water quality and sedimentation rates that are in equilibrium with the watershed. In addition, trout are commonly fished and are a demand species. Furthermore, some management activities, such as stream liming and habitat restoration, are specifically designed to improve brook trout habitat and increase their populations. MIS population trends and changes are analyzed for wild trout, rather than hatchery reared fish, since many stocked streams are not suitable for year-round survival or recruitment of a self-sustaining population. VDGIF tracks wild brook trout populations on selected Forest streams. Wild trout are also a species that could be highly sensitive to stream temperature changes associated with climate change. This MIS is discussed under the Fisheries and Aquatic Habitat section of this Chapter.

Beaver

Beavers (*Castor canadensis*) were selected as an MIS because they are a keystone species that create wetland habitat with many physical and biological benefits. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent positive effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Restoring beaver populations to their maximum viability on public lands is desirable because of the beaver's capability to restore and maintain healthy riparian ecosystems. Key conservation elements for the beaver on National Forest System lands are, therefore, protection and enhancement of aquatic and riparian habitats by management of water resources and riparian vegetation, beaver population enhancement by natural recolonization and transplants where necessary, and proactive management of beaver damage issues.

FOREST TRENDS

The primary conservation concerns are to ensure that existing beaver populations remain viable and to restore beaver populations to unoccupied habitat where appropriate to take advantage of their capability to restore and strengthen the ecological integrity of aquatic and riparian ecosystems. Beaver management plans must take into account landscape-scale habitat management. To maintain viable populations, managers should ensure that land uses maintain connectivity between watersheds to facilitate long-range dispersal and gene flow. This scale of management maintains metapopulation dynamics and allows natural dispersal to repopulate watersheds where beavers have been reduced or extirpated by natural or human causes. At project-level scales, management practices that potentially affect riparian vegetation and stream hydrology or morphology should mitigate adverse impacts to beaver habitat, and enhance beaver habitat where possible.

Beavers are vulnerable to overharvest because of the relative ease of capture, their dependence on aquatic habitat, delayed sexual maturity, and a slow reproductive rate. Since beavers are regulated by the state wildlife agencies as a furbearer species, maintaining viable beaver populations will require cooperative management plans that account for overharvest vulnerability, to ensure that local or regional populations are not decimated by excessive exploitation and that National Forest wetland habitat conditions are being met. Ensuring a sustainable harvest may include designating some areas as off limits to trapping.

The following areas have been identified as important beaver habitat sites because of the quality and quantity of long-term wetland habitat that beavers have created. Since beavers are a new MIS there is no existing trend analysis. In the future, these areas will be monitored for beaver activity.

Table 3B2-17. Key Beaver Habitat Sites on the GWNF

Ranger District	Important Beaver Habitat Site	Current Beaver Activity
Warm Springs	Laurel Fork	Low
Pedlar	Maple Flats	Moderate
North River	Tillman Road	Low
Lee	Paddy and Cove Runs	High

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Future trends in MIS are discussed in various sections of this document. These are identified in Table 3B2-18. Table 3B2-19 displays the objectives for habitat management for each Management Indicator Species by alternative.

In summary, 14 species have been selected as management indicator species. They will be used to assess effects of alternatives and to help monitor effects of implementing the selected alternative.

Within specific major forest communities and terrestrial habitats there is discussion of individual MIS and their expected response to each alternative. Viable populations of management indicator species are expected within all alternatives, but the mix of habitat components, by alternative, will influence the degree to which increases or decreases are expected for each MIS.

Table 3B2-18. Location of Discussion of Management Indicator Species Effects

MIS Common Name	Location of Discussion of Future Trends by Alternative
Cow Knob Salamander	Habitat management is directed through establishment of the Shenandoah Mountain Crest-Cow Knob Salamander Management Prescription Area. The direction was prepared as part of the Conservation Agreement and is expected to maintain or improve current populations.
Pileated Woodpecker	This MIS is part of the Cavity Trees, Den trees and Snags group of species and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Ovenbird	This MIS is part of the Area Sensitive Mature Coniferous, Deciduous, and/or Mixed Forest Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Chestnut-sided Warbler	This MIS is part of the High Elevation Openings, grassy or shrubby or open woodlands Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Acadian Flycatcher	This MIS is part of the Riparian Area Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Hooded Warbler	This MIS is part of the Late Successional Hardwood Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Scarlet Tanager	This MIS is part of the Open woodlands Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter under Oak Forests and Woodlands. Population trends of the species in this group by alternative are found in Table 3B2-3.
Pine Warbler	This MIS is part of the Fire Dependent and Fire Enhanced Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter under Pine Forests and Woodlands. Population trends of the species in this group by alternative are found in Table 3B2-3.
Eastern Towhee	This MIS is part of the Regenerating Forests Associates and is discussed in the Ecological Sustainability Assessment (Species Diversity Report), as well as the Terrestrial Diversity Section of this Chapter. Population trends of the species in this group by alternative are found in Table 3B2-3.
Wild Brook Trout	This MIS is discussed under the Fisheries and Aquatic Habitat section of this Chapter.
Eastern Wild Turkey	This MIS is discussed under the Demand Species section of this Chapter.
Black Bear	This MIS is discussed under the Demand Species section of this Chapter.
Deer	This MIS is discussed under the Demand Species section of this Chapter.
Beaver	With emphasis on beaver, it is expected that populations will increase under all alternatives.

Table 3B2-19. Management Indicator Species Habitat Management by Alternative

MIS Common Name	Objectives for Habitat Management by Alternative
Cow Knob Salamander	All alternatives utilize the Shenandoah Mountain Crest-Cow Knob Salamander Management Prescription Area to implement the Conservation Agreement for the salamander.
Pileated Woodpecker	All alternatives incorporate the suite of standards to address the needs of the cavity trees, den trees and snags groups of species. All alternatives also result in a large proportion of the forest in late successional stages.
Ovenbird	The ecological systems objectives all include a substantial portion of the systems meeting the needs of the area sensitive mature forest associate species group. This need will be met in all alternatives.
Chestnut-sided Warbler	All alternatives will meet some of the objectives for the high elevation openings species group. However, Alternative C relies on natural processes, so does not actively increase the amount of regeneration at high elevations. The amount of regeneration at high elevation varies by alternative.
Acadian Flycatcher	All alternatives have objectives for riparian areas. Alternatives B, C, E, F, G, H and I (D to a lesser extent) all expand the width of riparian area corridors.
Hooded Warbler	All alternatives have objectives to maintain large amounts of late successional habitat with Alternative C having the largest.
Scarlet Tanager	All alternatives utilize fire to some extent to create open woodland habitat. Alternative C relies on wildfire and Alternative A has a small amount of prescribed fire. The other alternatives all increase the level of prescribed fire to create this condition.
Pine Warbler	Pine habitat is also dependent upon wildland fire. See description for scarlet tanager.
Eastern Towhee	All alternatives will meet some of the objectives for the regenerating forest species group. However, Alternative C relies on natural processes, so does not actively increase the amount of regeneration. The amount of regeneration varies in each of the other alternative.
Wild Brook Trout	All alternatives address the objectives of maintaining and restoring the aquatic systems.
Eastern Wild Turkey	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Black Bear	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Deer	The objectives for this species are largely a combination of the open woodland and regenerating forest species groups.
Beaver	All alternatives address the objectives of maintaining and restoring the aquatic systems. Alternatives B, C, E, F, G, H and I (D to a lesser extent) all expand the width of riparian area corridors. Restoration of beaver habitat is an emphasis in Alternatives E, G, H and I.

B3 – OLD GROWTH

Summary of Old Growth Guidance

In 1989 then-Chief Dale Robertson issued a national position statement on old growth. This included a national generic definition and description of old growth forests that is still applicable today:

> Old growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics that may include tree size, accumulation of large dead woody material, number of canopy layers, species composition, and ecosystem function.
>
> The age at which old growth develops and the specific structural attributes that characterize old growth will vary widely according to forest type with climate, site conditions, and disturbance regime. For example, old growth in fire-dependent forest types may not differ greatly from younger forests in the number of canopy layers or accumulation of downed woody material.
>
> Old growth is typically distinguished from younger growth by the following structural attributes and characteristics:
>
> 1. Large trees for that species and site.
> 2. Uneven age structure with tree species in several size classes resulting in multiple canopy layers.
> 3. Accumulations of large-size dead standing and fallen trees that are high relative to earlier stages and in all stages of decay.
> 4. Broken or deformed tops or bole and root decay primarily resulting from weather phenomena such as ice or wind storms.
> 5. Single or multiple tree-fall gaps usually resulting from windthrow and resulting in understory patchiness and increased micro-topography relief.
> 6. Undisturbed soils and soil macropores usually with a well-developed surface organic layer (0 horizon).
> 7. On mesic sites there is a well-developed fungal component.

Beginning in 1990, the Southern and Eastern Regions of the Forest Service; the Forest Service Southern, Northeastern, and North Central research stations; and The Nature Conservancy began efforts to develop science-based old growth definitions for the east. The effort proved to be problematic in large part because so few representatives of old growth conditions exist and their history for their entire life so poorly known that quantifying the range of natural variability was imprecise. But after five years of effort, in December of 1995, the Southern Regional Forester chartered the Region 8 Old Growth Team to make the draft scientific old growth definitions ‘operational and useful’. In June of 1997 the Team completed a report entitled *Guidance for Conserving and Restoring Old-Growth Forest Communities on National Forests in the Southern Region*, hereafter called the ‘old growth report’ (Forest Service1997). This report continues to guide management of old growth on the Southern Region Forests.

The old growth report recognized old growth forests as a valuable natural resource worthy of protection, restoration, and management that provides a variety of ecological, social, and spiritual values. Old growth communities are rare or largely absent in the southeastern forests from Virginia south to Florida. Existing old growth areas (referred to as ‘primary forests’) may represent around 0.5% (approx. 482,000 acres) of the total forested acreage of 88,079,000 acres (Davis 1996). For these reasons the Southern Region’s National Forests are making efforts to restore more of this portion of forest ecosystems.

The old growth report gave operational definitions for sixteen old growth community types that encompassed nearly all of the forest cover types in the Southeast. Factors used to define old growth forest type (OGFT) groups are those that most strongly influence the structural and functional characteristics of old growth forests. These include site factors that directly or indirectly affect productivity and spacing of trees, disturbance regimes, physiognomy, dominant tree species, and geography (in that geography is related to climate, which

controls productivity, in part). A few forest cover types were not included such as those considered rare communities plus the tropical forests of the Caribbean.

For each old growth forest type, minimum ages were determined at which a stand will begin to develop attributes characteristic of old growth conditions. Several accepted definitions used to describe old growth state that a given old growth forest type will begin to develop old growth characteristics at an age approximately one-half the maximum longevity (lifespan) of the dominate tree(s) found in that type (Cogbill 1983; Leverett 1996; Loehle 1988). The nine old growth forest type groups that occur on the Forest have five different ages at which they begin to develop old growth characteristics ranging from 100 to 140 years. These groups not only reflect the longevity of dominant trees, but natural disturbance regimes (fire, ice storms, gap formation, etc.) and edaphic conditions (rainfall, slope, aspect, etc.) where they are found.

The operational definitions established four criteria which had to be met before a stand would be considered 'existing' old growth: (1) AGE - minimum age in the oldest age class; (2) PAST DISTURBANCE - no obvious human-caused disturbance that conflicts with old growth characteristics for that type; (3) BASAL AREA - minimum basal areas of stems 5" d.b.h. and larger; and (4) TREE SIZE - a minimum diameter at breast height (d.b.h.) of the largest trees. Except for (2), the values for these criteria vary by old growth type. The report also generally charged each Forest to provide: (1) a distribution of large (more than 2,500 acres), medium (100 thru 2,500 acres), and small (1 through 99 acres) possible old growth patches; and (2) representation of all possible and applicable old growth forest types for each ecological section unit (e.g. physiographic region). An exception to the large block requirement was made for forests in the Northern and Southern Cumberland Plateau and the Appalachian Piedmont ecological sections because of land ownership patterns. The distribution guidance did not specify an amount, such as acres or percent of area, to be in each patch size. In addition, old growth patches were assumed to be occurring on National Forests in a matrix of mid- to late successional forest conditions, providing connectivity without old growth allocations being physically contiguous. Representation was limited to ensuring that old growth community types were present, not a total amount nor an amount per each type. Amounts (i.e. acres) were to be based on public issues and ecological capabilities of the land.

The Biological Significance of Old Growth

To date no species of plant or animal had been identified in the Southeastern United States that is considered an old growth obligate; that is, requiring old growth for some portion or all of their life cycle. Therefore, the provision of existing or future old growth is not directly linked in a cause and effect relationship to the viability of any species.

However, old growth and associated late successional forests and woodlands are a condition that is particularly rich in habitat attributes for a variety of species and these attributes occur in close association (intra-stand) with one another as opposed to a landscape scale (inter-stand) distribution. A wider variety of habitat niches are available than in earlier life stages of the same community. The long development period is conducive to the formation of complex vertical structure that may include emergent trees, dominant and co-dominant trees, suppressed trees, and a forest floor shrub layer and/or an herb/forb/grass layer. Canopy gaps of various sizes caused by: (a) the death in-place of a single tree; or (b) the deaths in-place of small groups of trees; or (c) the falling of a group of trees, in comparison with their immediate surroundings provide micro-sites with higher light regimes, higher stem counts, and an edge effect both around the edge of the gap and back into the surrounding stand. Standing dead trees provide large and small diameter snags for foraging, perching, and cavity excavation. Down logs and limbs provide a substrate for wood decomposing fungi and insects; cover for small mammals, amphibians, and insects; and in later stages a 'nurse log' for the establishment of new tree seedlings. Large-diameter living trees, with a long-term exposure to natural damaging agents, have the potential through wood-rotting fungi activity for the formation of large cavities suitable for bear, raccoon, squirrel, bats, or other cavity users. The heavy limb structure that develops in some tree species as they age provides sturdy nest platforms for species such as bald or golden eagles.

The Social Significance of Old Growth

Whether biologically necessary to species or not, old growth is of value. There seems to be a general sense that it is intelligent to be sure to have this habitat condition on the landscape. In Aldo Leopold's words, '*The first rule of intelligent tinkering is to keep all the parts.'* As with Wilderness, there also appears to be a desire for places almost completely unmodified by humans whether or not those holding such a value ever visit them; that is, an 'existence' value. There can be, and often is, a historical, cultural or spiritual value associated with old growth whether it is a few acres, hundreds of acres, or even thousands of acres. There also is value in providing old growth of different types on a variety of landscapes that each person holding that value can readily relate to. That is, it is not enough to say something valued is being provided simply 'somewhere'.

In more pragmatic terms, old growth has other recognized social values. It is a desirable recreation setting, both for its biological variety and for the associated state of mind from knowing one is in an 'old growth' setting perhaps surrounded by an open forest of big trees. It serves as a 'biological time machine' in that it is a reference area for what ecologically-comparable areas may have been previously and can be restored to given a similar amount of time and disturbance history. They are a valuable part of showing a comprehensive whole of ecological dynamics in conservation education. They are also a source of scientific information for research such as dendrochronology (tree ring analysis) used in studies of disturbance regimes and climate fluctuations.

Implementation of Old Growth Guidance in Forest Plan

The GWNF has used the 1997 Regional Guidance to help address this component of biodiversity in the delineation of old growth, both possible and existing. Small, medium, and large sized patches have been identified using stand ages contained in FSVeg and analyzed their spatial arrangement using GIS. Existing Wilderness, recommended Wilderness study areas, remote backcountry areas, and other prescriptions with large acreages, such as Special Biological Areas and Shenandoah Mountain Crest, provide for the large blocks both now and in the future.

AFFECTED ENVIRONMENT

Existing old growth was defined in the old growth report as '…forest stands that meet all four criteria (age, disturbance, basal area, and tree size) described in the operational definitions for that applicable old growth forest type. Possible old growth is defined as Forest stands which meet one or more of the preliminary inventory criteria from the Old Growth Guidance. FSVeg forest types were aggregated into the appropriate Old Growth Forest Type (OGFT) as described in the Regional Guidance Report and those stands meeting the minimum age were then tagged as the initial inventory of possible old growth. Ages have been determined for each stand on the Forest during the prescription process for all compartments and stands on the Forest. Most of the polygons identified through this process have not been visited to verify the existence of old growth per the four elements of the criteria. The current inventory is an initial screen and inventory. During project implementation those stands in the project area identified as possible old growth will be examined to determine if they meet the four criteria and are therefore considered existing old growth. Table 3B3-1 displays the current acres of possible old growth by type and compares that with the acreage of that type regardless of age. This table also projects the future amount of possible old growth at +10 and +50 years as the forest continues to get older.

Table 3B3-1. Amount of Possible Old Growth by Old Growth Forest Type as of 2010

OGF Type #	Old Growth Forest Type Name	Min. Age	Current Total Acres On GW All Ages	Current Areas Acres (& %) Possible Old Growth	Current Areas +10 yrs Acres & % Possible Old Growth	Current Acres +50 yrs & % Possible Old Growth
1	Northern Hardwood Forest	100	9,644	1,263 (13%)	4,491 (47%)	8,457 (88%)
2	Conifer-Northern Hardwood Forest	0	0	0	0	0
2a	Hemlock-Northern Hardwood	140	6,574	2,494 (38%)	3,010 (46%)	5,194 (79%)
2b	White Pine-Northern Hardwood	140	37,711	688 (2%)	1,741 (5%)	9,888 (26%)
2c	Red Spruce-Northern Hardwood	120	524	118 (23%)	118 (23%)	255 (49%)
5	Mixed Mesophytic Forest	140	57,515	5,064 (9%)	7,936 (14%)	32,905 (57%)
10	Hardwood Wetland Forest	120	111	0 (0%)	0 (0%)	0 (0%)
21	Dry- Mesic Oak	130	678,932	151,371 (22%)	207,224 (31%)	598,663 (88%)
22	Dry and Xeric Oak	110	492	331 (67%)	467 (95%)	467 (95%)
24	Xeric Pine and Pine Oak	100	124,374	66,468 (53%)	101,758 (82%)	118,709 (95%)
25	Dry and Dry Mesic Oak-Pine	120	122,525	16,850 (14%)	36,224 (30%)	113,658 (93%)
28	Eastern Riverfront Forest	100	194	6 (3%)	25 (13%)	76 (39%)
TOTAL Acreage and % of Current			1,038,596	244,653 (24%)	362,996 (35%)	888,271 (86%)

The network, or spatial distribution, of old growth by patch size is of importance as described in the Regional Guidance report. Currently (2010) the inventory of possible old growth identified 1,749 small patches (1-99 acres) totaling 58,773 acres, and 450 medium sized patches (100-2,499 acres) totaling 152,657 acres, and 7 large patches (>2,499 acres) totaling 33,107 acres across the GWNF. The average size of small patches is 34 acres, 339 acres for medium sized patches, and 4,730 acres for large patches. Table 3B3-2 shows the current condition of patches and their condition projected to be in 10 and 50 years from now.

Table 3B3-2. Number and acreage of small, medium, and large patches

Patch Size	Current (2010)		Current +10 years		Current +50 years	
	# of Patches	Acres	# of Patches	Acres	# of Patches	Acres
Small (1-99 acres)	1,749	58,828	1,846	60,534	234	7,476
Medium (100-2,499 acres)	450	152,714	522	202,909	108	56,050
Large (>2,499 acres)	7	33,111	19	99,553	32	824,745
Total	2,206	244,653	2,387	362,996	374	888,271

DIRECT AND INDIRECT EFFECTS

Each alternative evaluated in detail includes management prescriptions that either have the intent of protecting possible old growth and expanding it, or of providing old growth indirectly as the result of management that limit timber harvest. But, as noted in the old growth report, the primary focus of old growth management in the near and medium term is restoring it on the landscape. And the primary (not the only) component of restoration is simply time; time for existing stands to age through the gradual development of old growth conditions. For that reason, alternatives are compared by how old growth forest types will be managed and the sum of the acreage they allocate to old growth compatible prescriptions.

Table 3B3-3 displays the amount of possible old growth that is located in management prescription areas that are unsuitable for timber production. Tables 3B3-4 and 3B3-5 display the same information, but projected out 10 and 50 years.

Table 3B3-3. Current Percent of Possible Old Growth in Prescriptions Unsuitable for Timber Production

OGF Type #	Old Growth Forest Type Name	Current Acres (2010) of Possible Old Growth	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
1	Northern Hardwood Forest	1,263	90%	90%	100%	91%	91%	96%	91%	91%
2	Conifer-Northern Hardwood Forest	0	0	0	0	0	0	0	0	0
2a	Hemlock-Northern Hardwood	2,494	95%	92%	100%	92%	94%	96%	94%	94%
2b	White Pine-Northern Hardwood	688	53%	33%	100%	35%	44%	66%	40%	40%
2c	Red Spruce-Northern Hardwood	118	100%	100%	100%	100%	100%	100%	100%	100%
5	Mixed Mesophytic Forest	5,064	61%	55%	100%	56%	63%	66%	60%	61%
10	Hardwood Wetland Forest	0	0	0	0	0	0	0	0	0
21	Dry- Mesic Oak	151,371	58%	46%	100%	46%	55%	68%	54%	54%
22	Dry and Xeric Oak	331	71%	48%	100%	48%	48%	71%	48%	48%
24	Xeric Pine and Pine Oak	66,468	51%	40%	100%	41%	50%	62%	47%	46%
25	Dry and Dry Mesic Oak-Pine	16,850	55%	49%	100%	48%	60%	69%	55%	56%
28	Eastern Riverfront Forest	6	0%	0%	94%	0%	0%	0%	0%	0%
TOTAL Acreage		244,653	56%	45%	100%	46%	55%	67%	53%	53%

Table 3B3-4. Percent of Possible Old Growth in 2020 in Prescriptions Unsuitable for Timber Production

OGF Type #	Old Growth Forest Type Name	Acres of Possible Old Growth in 2020	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
1	Northern Hardwood Forest	4,491	91%	90%	100%	90%	90%	94%	90%	90%
2	Conifer-Northern Hardwood Forest	0	0	0	0	0	0	0	0	0
2a	Hemlock-Northern Hardwood	3,008	90%	87%	100%	87%	89%	91%	89%	89%
2b	White Pine-Northern Hardwood	1,745	39%	27%	100%	27%	37%	49%	35%	37%
2c	Red Spruce-Northern Hardwood	118	100%	100%	100%	100%	100%	100%	100%	100%
5	Mixed Mesophytic Forest	7,936	58%	52%	100%	52%	60%	65%	58%	58%
10	Hardwood Wetland Forest	0	0	0	0	0	0	0	0	0
21	Dry- Mesic Oak	207,333	56%	44%	100%	45%	53%	67%	52%	52%
22	Dry and Xeric Oak	467	56%	40%	100%	40%	40%	56%	40%	40%
24	Xeric Pine and Pine Oak	101,728	52%	40%	100%	40%	49%	62%	46%	46%
25	Dry and Dry Mesic Oak-Pine	36,379	48%	39%	100%	39%	51%	63%	47%	47%
28	Eastern Riverfront Forest	25	24%	0%	101%	0%	0%	24%	0%	0%
TOTAL Acreage and % of Current		362,230	55%	44%	100%	44%	53%	66%	51%	51%

Table 3B3-5. Percent of Possible Old Growth in 2060 in Prescriptions Unsuitable for Timber Production

OGF Type #	Old Growth Forest Type Name	Acres of Possible Old Growth in 2060	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
1	Northern Hardwood Forest	8,457	87%	87%	100%	87%	87%	92%	87%	87%
2	Conifer-Northern Hardwood Forest	0	0	0	0	0	0	0	0	0
2a	Hemlock-Northern Hardwood	5,193	77%	70%	100%	72%	74%	82%	74%	75%
2b	White Pine-Northern Hardwood	9,896	31%	23%	100%	24%	29%	42%	28%	28%
2c	Red Spruce-Northern Hardwood	255	65%	65%	100%	65%	65%	65%	65%	65%
5	Mixed Mesophytic Forest	32,854	55%	48%	100%	49%	54%	63%	53%	53%
10	Hardwood Wetland Forest	0	0	0	0	0	0	0	0	0
21	Dry- Mesic Oak	598,543	53%	41%	100%	41%	49%	64%	48%	48%
22	Dry and Xeric Oak	467	56%	40%	100%	40%	40%	56%	40%	40%
24	Xeric Pine and Pine Oak	118,636	52%	40%	100%	40%	49%	62%	46%	46%
25	Dry and Dry Mesic Oak-Pine	113,820	50%	40%	100%	40%	50%	63%	47%	47%
28	Eastern Riverfront Forest	76	22%	14%	100%	14%	14%	22%	14%	14%
TOTAL Acreage and % of Current		888,196	53%	41%	100%	42%	49%	63%	48%	48%

In addition to old growth allocated to management prescription areas that are unsuitable for timber production, some alternatives have additional protections for old growth. Possible old growth identified by type and minimum age plus areas identified in the field as old growth according to the 4-part Regional criteria in old growth forest types (OGFT) 1, 2a, 2b, 2c, 5, 10, 22, 24, and 28 will be considered unsuitable for timber production in all alternatives. In Alternatives C, E, and F OGFTs 21 and 25 are added to the list as unsuitable for timber production. In Alternative A and B possible and existing OGFT 21 stands on suitable ground remain suitable. In Alternative D, G, H and I possible and existing old growth in both OGFTs 21 and 25 stands on suitable ground remain suitable.

In Alternatives A and B it is estimated that the amount of timber harvested from stands in OGFT 21 that meet the definition of old growth would be less than 3,000 acres during the next ten years. In Alternative D it is estimated that the amount of timber harvested from stands in OGFTs 21 and 25 that meet the definition of old growth would be less than 5,000 acres during the next ten years, with about 4,000 in OGFT 21. In Alternatives G, H and I, it is estimated that the amount of timber harvested from stands in OGFTs 21 and 25 that meet the definition of old growth would be less than 3,000 acres during the next ten years, with about 2,400 in OGFT 21.

Therefore, prior to scheduling any silvicultural practices on lands classified as suitable for timber production in OGFT 21 (dry-mesic oak forests) and/or OGFT 25 (dry and dry-mesic oak-pine forests), stands are inventoried using the Southern Region's Guidance (Forestry Report R8-FR 62) depending on the alternative. Silvicultural practices could proceed after site-specific analysis and disclosure which included a discussion on the old growth characteristics found in the stand(s) of the project area, the effect of the action on these characteristics, and the effect the action would have on the contribution of the area to the Forest's "old growth" inventory.

Currently the GWNF Forest Plan states that timber harvesting can only occur within the Dry Mesic Oak Type (OGFT 21), as all other stands meeting the minimum age in other groups were classified during the Forest Plan revision process as unsuitable for timber production. While some individual old age stands of the Dry Mesic Oak type were cut for timber during the past 18 years (<1,000 acres), the total acreage of stands meeting the minimum age within the that group continues to increase. From 1993 to 2010 there was an increase of 63,379 acres (72%) from 87,889 to 151,268 acres in OGFT 21. Thus, timber harvesting is not significantly limiting the old growth forest conditions on the GWNF, and in particular OGFT 21 since it is the most common and widespread group on the GW. However, it is recognized that once a specific acre of existing old growth is regenerated, that acre will not achieve old growth characteristics within our lifetime.

Fire is a natural disturbance process common to most OGFTs (but is very infrequent in northern hardwoods, spruce/fir, and riverfront forests) (USDA 1997; Trombulak 1996). Thus, the increased use of prescribed fire is not affecting the overall amount of old growth across the Forest, but instead is restoring and maintaining vegetation in species composition and structure more typical of the fire regime these forests experienced prior to active fire suppression (~1930s). In the absence of fire as a major landscape scale disturbance (which it once was) the structure and composition of forests, regardless of age, will not meet historic old growth conditions (NatureServe; Landfire; Native Tree Society). These forests will be much more closed canopy and closed understory as opposed to the open canopy and very open understory that historically existed. We will meet the age requirements for an old growth forest but will lack much of the associated structure. Thus, the acreage of all old growth forest types meeting minimum necessary ages is steadily increasing as the forest continues to increase in age, but stand structure in most types is not being met due to lack of fire related disturbances.

“Future old growth” are those forest stands or patches allowed to develop old growth characteristics through lack of timber harvest, but which do not currently meet the operational definition for existing old growth. Table 3B3-6 shows that Alternative C provides for the greatest level of future old growth being found in larger blocks. This alternative contains the greatest acreage within future old growth since over one-third of the total Forest acreage is in Recommended Wilderness Study Areas. It also would contain the largest potential old growth blocks. This is followed by Alternatives F, A, E, G, H and I respectfully. Alternatives B and D provides the least amount of future old growth.

Table 3B3-6. Acreage in Key Management Prescriptions that will provide for Most Large Blocks (>= 2,500 acres) of Future Old Growth, by Alternative

Management Prescription	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
Designated Wilderness	42,954	43,049	42,992	42,992	42,992	42,992	42,992	42,992
Recommended Wilderness Study	1,413	20,422	386,786	14,627	24,325	112,144	20,314	27,365
Research Natural Area	2,808	1,980	1,979	1,979	1,979	1,979	1,979	1,979
Special Biological Area	24,454	51,427	21,303	51,574	51,574	30,438	51,565	52,585
Key Natural Heritage Community Area	0	0	0	0	0	0	3,308	3,324
Mt Pleasant National Scenic Area	7,753	7,742	7,744	7,744	7,744	7,744	7,744	7,744
Recommended National Scenic Area	0	0	0	8,241	0	107,717	0	67,479
Mix of Successional Habitats – Unsuitable	69,736	0	0	0	0	0	0	0
Black Bear / Remote Habitats - Unsuitable	61,204	0	0	0	0	0	0	0
Shenandoah Mtn Crest – Cow Knob Salamander	43,137	46,692	20,343	53,855	49,644	23,382	46,812	23,832
Remote Backcountry	198,858	191,935	113,852	190,423	264,184	167,845	252,159	200,814
Mosaics of Habitat - Unsuitable	0	0	245,678	0	3,308	109,380	0	0
Total Acres	452,317	363,247	840,677	371,435	445,750	603,621	426,873	428,114

A comparison of the patches of old growth that are in management prescription areas that are unsuitable for timber production is shown in Table 3B3-7.

Table 3B3-7. Percent of Old Growth Patches in 2010, 2020, and 2060 in Prescriptions Unsuitable for Timber Production

Patch Size	# of Patches	Acres	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
			%	%	%	%	%	%	%	%
Current Condition (2010)										
1 (1-99 acres)	1,749	58,828	44%	31%	100%	32%	39%	55%	37%	37%
2 (100-2,499 acres)	450	152,714	56%	45%	100%	45%	55%	67%	53%	54%
3 (>2,499 acres)	7	33,111	79%	73%	100%	74%	81%	88%	76%	76%
Total # and acres	2,206	244,653	56%	45%	100%	46%	55%	67%	53%	53%
Condition in 10 Years (2020)										
1 (1-99 acres)	1,846	60,481	43%	30%	100%	30%	37%	53%	35%	35%
2 (100-2,499 acres)	522	202,857	52%	40%	100%	40%	47%	63%	46%	46%
3 (>2,499 acres)	19	99,547	69%	59%	100%	59%	73%	79%	69%	69%
Total # and acres	2,387	362,885	55%	44%	100%	44%	52%	66%	51%	51%
Condition in 50 years (2060)										
1 (1-99 acres)	234	7,379	25%	11%	100%	12%	13%	32%	12%	13%
2 (100-2,499 acres)	108	55,872	39%	11%	100%	11%	13%	41%	12%	12%
3 (>2,499 acres)	32	824,517	54%	44%	100%	44%	52%	65%	51%	51%
Total # and acres	374	887,767	53%	41%	100%	42%	49%	63%	48%	48%

CUMULATIVE EFFECTS

Beyond the expected and naturally occurring disturbances like wind, ice, fire, native insects and disease the biggest impact upon existing and future old growth will be alterations in disturbance regimes and effects of non-native insect and disease events. Hemlock woolly adelgid is likely to have as large of an impact on eastern and Carolina Hemlocks as chestnut blight had on American chestnuts. Other major impacts will result from naturalized non-native pests like gypsy moths, European boars, beech-bark disease, and butternut blight and their induced mortality is expected to severely impact certain old growth types. The greatest effect of alteration in natural disturbance regimes is the decrease in fire disturbance across most OGFTs. Fire is discussed elsewhere in this EIS but the overall effect of an altered fire regime has been to alter many old growth characteristics related to species composition and structure with current conditions much more closed canopy and species tolerant to shade species such as red maple and white pine increasing while fire tolerant species decrease. But, regardless of alternative, the maturation of the Forest will continue and an increase in old growth as a function of age is expected into the future. Tables 3B3-1 and 3B3-2 show how the acreages increase and shift in 10 and 50 years for the types and the patches. Continued inventory for old growth will occur at the project level.

B4 – AQUATIC SPECIES DIVERSITY

B4A - FISHERIES AND AQUATIC HABITAT

AFFECTED ENVIRONMENT

The Forest has approximately 1,171 miles of perennial streams and 2,348 miles of intermittent streams. Of the perennial streams, about 702 miles are classified as supporting a cold water (less than 70 degree water temperatures) fishery, and 469 miles are classified as supporting cool or warm water fisheries (temperatures greater than 70 degrees during summer months). In addition, the Forest has 3,229 acres of lakes, ponds, wetlands and reservoirs greater than 1 acre.

Habitats

Water Quality

Water quality has been systematically monitored on Forest streams since 1988. As expected, the general water quality of any given stream is strongly tied to the underlying geology coupled with prevailing air quality. The collected data has been used to determine trends and changes in stream water composition, and to project the future chemical status of native trout streams. Water quality in the cold water stream habitat is generally described as infertile with total alkalinity less than 20 parts per million (ppm), and slightly to very acidic with pH as low as 4.8. A 1998 report (Bulger et al. 1998) found that of the study streams in non-limestone geology, 50 percent are “non-acidic.” An estimated 20 percent are extremely sensitive to further acidification. Another 24 percent of the streams experience regular episodic acidification at levels harmful to brook trout and other aquatic species. The remaining 6 percent of streams are “chronically acidic” and cannot host populations of brook trout or any other fish species. Modeling conducted by the Southern Appalachian Mountain Initiative (SAMI), showed that even with sulfate deposition declining considerably, as new air regulations are implemented, stream recovery will be slow or non-existent over the next 100 years (Sullivan et al. 2004). Chronically acidic streams on the Forest may improve slightly and be only episodically acidic by 2100, but they will still be marginal for brook trout.

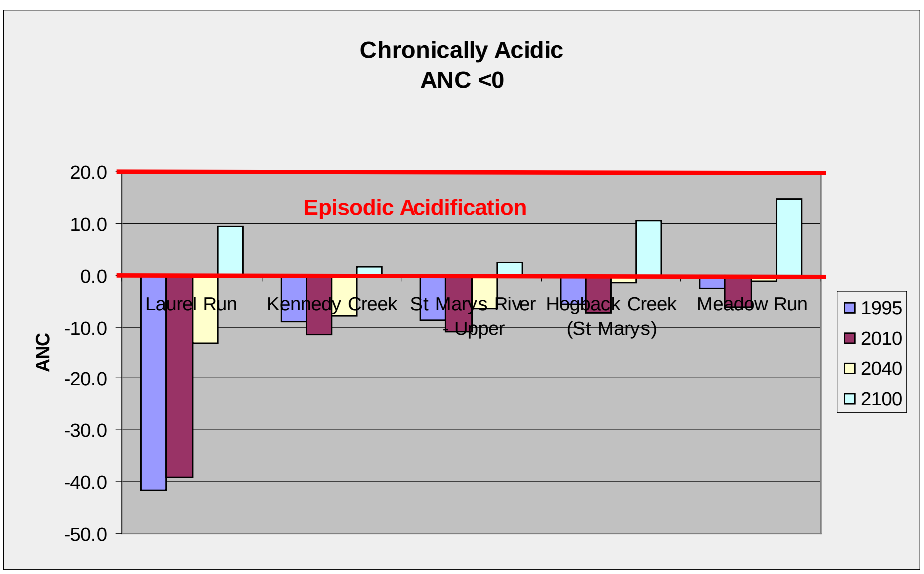


Figure 3B4-1. Chronically Acidic Streams

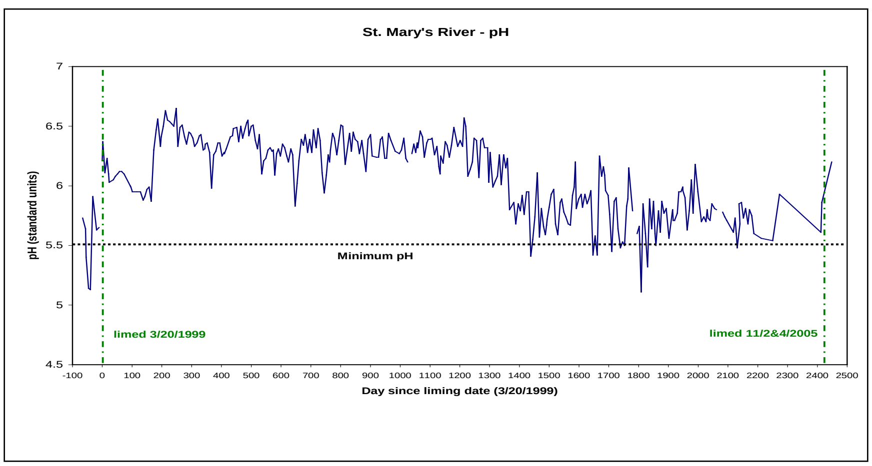
More recently, water chemistry analysis of 345 of Virginia's mountain streams sampled in 1987, 2000, and 2010 found that median acid neutralizing capacity (ANC) increased and median sulfate concentrations declined, indicating at least a partial recovery from acidification; with most of the recovery occurring since 2000. This recovery has been linked to the Clean Air Act Amendments of 1990 aimed at curbing emission, which have resulted in a significant decrease in rates of acidic atmospheric deposition (Miller 2011). However, analysis of quarterly stream chemistry data indicates that acidification is continuing in some Virginia brook trout streams (as indicated by a decrease in ANC and increase in sulfate concentrations), and that recovery from surface water acidification in western Virginia is generally less than in other eastern U.S. areas affected by acidic deposition (Webb 2011).

Due to the lengthy recovery time anticipated for acidified streams on the Forest, selective liming to improve water has been considered. The following streams have been limed on the GW Forest since 1989:

Table 3B4-1. George Washington National Forest Stream and Lake Liming

Date	Stream	County
1990, 1997	Cedar Creek	Shenandoah
1993, 1994, 1997	Laurel Run	Shenandoah
1997, 2000, 2003, 2006, 2009	Little Passage Creek	Shenandoah
1989, 1990,1991, 1998, 2001, 2004, 2007, 2010	Little Stony Creek	Shenandoah
1990, 1998, 2001, 2007	Mill Creek	Shenandoah
1993,1997, 1999, 2002, 2005, 2008	Mountain Run	Rockingham
2011	Pitt Spring Run	Page
1999	St. Mary's River & 5 tribs	Augusta
2005	St. Mary's River & 6 tribs	Augusta
1995, 1996, 1997, 1998, 1999	Trout Pond Run	Hampshire, WV

Trend in pH for one of the limed streams is shown below.



Water quality in the warm water stream habitat is generally higher in alkalinity and hardness, and not as susceptible to impacts from acid deposition because of more carbonate geology in the valley bottoms. Impacts to warm water streams often come from non-point source pollutants that enter the streams as they flow through private land.

For additional discussion on water quality, impaired waters, drinking water, and outstanding natural resource waters see the Water Resource section of EIS.

Physical Stream Condition

Large woody debris within a stream is ecologically important for instream habitat and productivity. Within the stream system, downed wood from riparian trees and shrubs greatly influence channel morphology and aquatic ecology. By altering stream flow, large woody debris stores and distributes sediment, and creates channel features, such as pools, riffles, and waterfalls. Wood also traps organic matter, which allows this material to be processed by instream organisms. Fish and insects occupy the pools and riffles created by the large woody debris, and riparian forest regeneration occurs on deposited sediment (Lassettre and Harris 2001).

Forest personnel surveyed stream habitat to measure desired parameters identified in the 1993 Revised GWNF Forest Plan. Surveys were conducted on portions of the Pedlar Ranger District in 1995 and 2005, Lee District in 2001, North River District in 2002, 2003, 2004 and 2005, and the Warm Springs in 2005. Overall, 631 km (392 miles) of streams were surveyed using a modified Basinwide Visual Estimation Technique (BVET [Dolloff et al. 1993]) to estimate woody debris loading, percentage of pool and riffle area, and the width of the riparian area of streams. The distribution of woody debris was also mapped. See Table 3B4-2 for a summary of LWD and % pool area.

Table 3B4-2. Miles of Stream Habitat Surveyed from 1995-2005 on GWNF

Year Surveyed	# of Stream Miles Surveyed	% of Streams Below Minimum Pool Area DFC	% of Streams Below Minimum LWD DFC
1995	113	48	44
2001	75	75	35
2002	57	62	33
2003	55	70	19
2004	35	71	78
2005	57	96	83

A comparison of individual streams surveyed in 1995 and again in 2005 on the Pedlar District showed a decrease in the median number of pools, number of riffles, and total LWD per km, while the median pool and riffle surface area increased. This report suggests that in 1995 only 25% of streams met the desired parameters for stream area in pools and less than half of streams met the desired conditions for total LWD. By 2005 no streams met the desired conditions for pool area and 75% of streams did not meet the desired conditions for total LWD. The changes in pool/riffle ratio, number of pools and riffles per km, and pool and riffle surface area are all consistent with decrease in total LWD. The largest decrease of LWD was in the smallest size class. These pieces most often form pool habitat by combining with other small woody debris to form debris jams. In general the smallest size classes are the most easily dislodged and transported downstream or out of the active stream channel during high flows (Hilderbrand et al. 1998; Montgomery et al. 2003). Loss of debris accumulations from long riffle areas following flood events could result in the changes in stream habitat observed. The median amount of the largest size classes of LWD either remained the same or increased in the reaches between 1995 and 2005.

Following 1993 Plan approval, across all Ranger Districts, large woody debris was deliberately added to many streams that did not meet the desired conditions. In addition, efforts were made in the North River to return a highly modified stream channel to a more natural condition. Past hydrological modifications of the North River include bank armoring with rock gabions and channelization to protect the road from frequent floods. These modifications resulted in a wide, shallow channel that lacks fisheries habitat complexity. Under a recent project, rock veins and weirs, and other structures made of natural materials were placed in the stream

channel to consolidate streamflow and increase sinuosity. Non-functional rock gabions blocking the natural floodplain were removed.

Physical Reservoir and Pond Condition

There are approximately 34 large man-made reservoirs on the GWNF; they were constructed by various agencies for the purposes of flood control, drinking water, hydro-electric and/or recreation between 30 and 80 years ago. The dams have affected the dammed streams in three ways: alteration of downstream flux of water and sediment, changed water temperatures, and barriers for upstream-downstream movement of organisms and nutrients. The resultant lake habitat has often been managed for fisheries (see next section). Many of these dams are aging; they were built to accommodate an estimated fifty year filling of the sediment pool and these life expectancies are being met or exceeded. In a new flood storage dam, the sediment pool is entirely occupied by water. Over time, the water is gradually replaced by sediment as the feeder stream transports material into the reservoir. An aged dam may thus have a recreational pool that is shallow and of limited habitat for fish, thus reducing recreation, while creating an area with greater likelihood for warming surface waters. In addition, the accumulated sediment may serve as a trap for airborne toxins such as mercury. Furthermore, the underwater structural habitat diversity (generally, trees and shrubs) that may have been present at time of lake development is decaying and needs to be replaced in order to maintain a healthy, self-sustaining warm water fish population within the reservoir.

Aside from the loss of recreation that accompanies the filling of the sediment pool, structural deterioration in primary spillways, degradation of secondary spillways, under-dam seepage and other problems are developing that can lead to dam failure. Many of these dams are under special use permits and owned by local entities such as Soil and Water Conservation Districts or municipalities, but the land on which they sit is National Forest. As these dams come up for refurbishment, the National Forest will review the purpose and need in light of its obligation to maintain integrity of the forest both for the use of humans and flora and fauna.

Small, natural impoundments such as beaver dams can be ecologically beneficial to an area. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. They create open, early successional habitat near riparian areas favored by species like woodcock.

The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Because they are porous and often have multiple channels through the dam, beaver dams generally do not restrict upstream or downstream movement of aquatic organisms. Beavers have disappeared, probably trapped out, from areas where they have previous played an integral habitat-maintaining role for many rare species (for example, the headwaters of Laurel Fork). Maintenance and restoration of beaver habitat across the Forest is necessary. Because of their role as a keystone species that create wetland habitat with many physical and biological benefits, beavers were chosen as Management Indicator Species (MIS).

Biota

The Southeastern United States supports the greatest diversity of freshwater mussel species in the world (Parmalee and Bogan 1998), and the richest freshwater fish fauna in North America north of Mexico (Warren et al. 2000). Looking at those species that are on or near the George Washington National Forest, 22 species of fish, aquatic invertebrates, and aquatic plants and mammals are listed as threatened, endangered, or sensitive (see Table 3B4-3). Because these species are associated with aquatic habitats, the effects to these and aquatic locally rare (LR) species are included in the general direct, indirect, and cumulative effects analyses below, and also addressed in the next section.

Table 3B4-3. Federally Threatened (T) or Endangered (E), and Forest Service Sensitive (S) Aquatic/Riparian Species On or Near the George Washington National Forest.

Scientific Name	Common Name	Status
Alasmidonta varicosa	Brook floater	S
Boltonia montana	Doll's daisy	S
Cicindela ancocisconensis	Appalachian tiger beetle	S
Elliptio lanceolata	Yellow lance	S
Fusconaia masoni	Atlantic pigtoe	S
Helenium virginicum	Virginia sneezeweed	FT
Helonias bullata	swamp pink	FT
Hydraena maureenae	Maureen's shale stream beetle	S
Iliamna remota	Kankakee globe-mallow	S
Isoetes virginica	Virginia quillwort	S
Lasmigona subviridis	Green floater	S
Notropis semperasper	Roughhead shiner	S
Noturus gilberti	Orangefin madtom	S
Peltigera hydrothyria	waterfan	S
Pleurobema collina	James spinymussel	FE
Poa paludigena	bog bluegrass	S
Potamogeton hillii	Hill's pondweed	S
Potamogeton tennesseensis	Tennessee pondweed	S
Scirpus ancistrochaetus	northeastern bulrush	FE
Sida hermaphrodita	Virginia mallow	S
Sorex palustris punctulatus	southern water shrew	S
Vitis rupestris	sand grape	S

Common native fish species in the cold water stream environments include brook trout, mottled sculpin, fantail darter, blacknose dace, longnose dace, and torrent suckers. Introduced species such as rainbow trout and brown trout are routinely stocked for sport fishing. In some Forest streams, these species have developed into naturalized populations. An effort has been made to eliminate introduced species from some native brook trout watersheds.

Wild trout (brook, rainbow, and brown) are indicative of cold water streams, good water quality and sedimentation rates that are in equilibrium with the watershed. In addition, trout are commonly fished and are a demand species. Wild brook trout were chosen as a MIS because many of the trout streams on the GW National Forest support wild native brook trout. MIS population trends and changes are analyzed for wild trout, rather than hatchery reared fish, since many stocked streams are not suitable for year-round survival or recruitment of a self-sustaining population.

Virginia has one of the strongest native brook trout resources in the Southeast. Wild brook trout populations are generally limited to higher elevations in the western mountains of the state. However, brook trout were once found throughout the limestone spring creeks in the Great Valley region located between the Blue Ridge and Allegheny mountain ranges and along some of the smaller tributaries of the Potomac at least as far east

as Fairfax County. Most of the valley limestone stream populations were likely extirpated a century or more ago with the agricultural development of the valley but some persisted as late as the mid-1960s. The populations within Potomac River tributaries were known to be strong through the 1950s and still persisted as late as the early 1980s. These populations were eliminated with residential development of the region. Recent research supports the relationship between forested watersheds and presence of brook trout; conversely, watersheds with extensive development (with as little as 4% impervious cover) were unable to support brook trout in their streams (Stranko et al. 2008). It is estimated that at least 38% of the original brook trout populations have been extirpated from Virginia.

Most of the remaining populations are well protected from land use changes due to public ownership. Land management agencies include the George Washington and Jefferson National Forests, the Shenandoah National Park and scattered holdings of the Virginia Department of Game and Inland Fisheries. The GWNF has 1,120 miles potential brook trout habitat in Virginia and West Virginia (see Aquatic Ecological Sustainability Analysis). The threats to this habitat that are not within the control of the National Forest include acid deposition and altered streamflow and temperature from climate change (see Climate Change section). However, impacts to trout and other cold-water species can hopefully be reduced by implementing the management strategies within the Forest Plan designed to maintain and protect healthy watersheds and support watershed resilience.

The Eastern Brook Trout Joint Venture (EBTJV) is a unique partnership between state and federal agencies, regional and local governments, businesses, conservation organizations, academia, scientific societies, and private citizens that is a geographically focused, locally driven, and scientifically based effort to protect, restore and enhance aquatic habitat throughout the range of the Eastern brook trout. Many of the watersheds identified as having “in-tact” brook trout populations by the EBTJV are on the GWNF; they have been identified as priority watersheds.

Cool/warm water streams across the Forest vary greatly in water quality and productivity. Common game fish species found in cool/warm water stream environments on the Forest include smallmouth bass, largemouth bass, redbreast sunfish, channel catfish, and rock bass. Typical non-game species include white sucker, carp, redhorse sucker, yellow bullhead, and a large variety of minnow and darter species. Chronic spring-time fish mortality and disease events occurred in the Shenandoah River 2004-2009, and in the upper James River 2007-2010. These episodes have not been uniform in location or severity over these time periods. Adult smallmouth bass, redbreast sunfish and rock bass have been the primary fish affected. However, several additional species have also been inflicted. Affected fish typically exhibit open sores or "lesions" on the sides of their bodies. Some dead and dying fish have no visibly external abnormalities. Other external symptoms include: dark patches of skin, raised bumps, loss of scales, split or eroded fins, and discolored/eroded gills. Determining the cause of these mortality and morbidity events has proven to be extremely difficult. Scientists have conducted in-depth studies on fish health, pathogens, water quality, and contaminant exposure. The fact that these events have occurred in two separate watersheds that differ in many ways has added to the complexity of understanding the cause. In the initial years of these events there was higher mortality observed and biologists estimated that fish losses were quite high. Fish biologists stressed that these were estimates and that the severity of the mortality and disease was not uniform throughout the rivers that were affected. However, several factors have allowed these fish populations to recover faster than anticipated; the most significant of these being excellent smallmouth reproduction between 2004 and 2007. The years 2004 and 2007 were two of the best spawning years in the past decade in the Shenandoah River. Virginia biologists have documented that river flow in the spring/early summer is what determines the success of the smallmouth bass spawn. It also only takes a small number of successful spawning fish to keep the population viable.

Most of the lake habitats on the Forest are small in size and relatively infertile with limited productivity. They routinely contain introduced largemouth bass, bluegill, and channel catfish. Trout species are stocked in lakes that have significant cold water environments. The largest reservoir on the Forest is Lake Moomaw, which was completed by the U. S. Army Corps of Engineers in 1981, and is the second largest impoundment in western Virginia. It covers 2,530 surface acres and the average depth of the reservoir is 80 feet, with the maximum depth at 150 feet near the dam. The impoundment is "drawn down" between 10-15 feet annually, beginning slowly in June and reaching its lowest level usually by September. There are 43 miles of undeveloped, wooded shoreline.

Lake Moomaw's geographic location and its operational procedure lend itself to thermal stratification in the summer. As much as 60,000 acre-feet of coldwater fisheries habitat is available in later summer for species such as brown and rainbow trout. Coldwater habitat varies annually depending on flow into the lake and downstream release loads. In summer 1993, the Corps of Engineers changed the way they released water out of the impoundment during summer/early fall. The Corps is required to provide 21º Celsius water at Covington, 30 km downstream of Gathright Dam, throughout this period. Currently, water from the epilimnion is mixed with cold, anoxic water from the hypolimnion, meeting downstream temperature requirements and preserving summer trout habitat in the lake. Alewives, the primary forage base, also thrive in the lake's two-story environment. Trout are the only sport fish that are stocked annually.

Changes in Moomaw's physical habitat have focused primarily on black bass populations. Warmwater fish species such as black bass, black crappie, rock bass, sunfish, chain pickerel, channel catfish, and yellow perch reproduce and grow in the flats, drop-offs, brush, and standing timber afforded to them along the lake's shoreline. Common carp found their way into the reservoir through bait introductions in the late 1990s. Artificial habitat such as tire reefs, artificial grass, cedar tree shelters, crappie stakes, pallet structures, log cribs, hinge trees, brush/tree piles, concrete structures, and PVC attractors have been deployed at various times in Lake Moomaw since 1981. Prior to impoundment, the Corps of Engineers left 40 hectares of standing timber in several coves and a few boulder piles in deep sections of the lower lake. Hundreds of stumps were also left along the shoreline, providing exceptional cover/nesting habitat for channel catfish. Addition of physical habitat has been accomplished jointly by DGIF, USFS, and local angling clubs. An inventory of past projects is maintained by USFS at the Warm Springs Ranger District office. A lake management plan was also jointly developed by DGIF and USFS in 1993.

Aquatic macroinvertebrates integrate the physical, chemical, and biological components of the riparian ecosystem and have been successfully used as biological indicators of change and impacts (Environmental Protection Agency 1989). Aquatic insects make up the largest group of invertebrates that live in streams and other water bodies. Because of their usefulness as biological indicators, aquatic macroinvertebrates will be used in monitoring the Forest Plan. Analysis of 925 sites on the George Washington and Jefferson National Forests established the current range of conditions for aquatic macroinvertebrate communities across the four ecological units found on the Forests. In order to evaluate the current condition of a stream relative to others within the same ecological unit, a compilation of nine ecological aspects, or metrics, of these communities were developed based on the EPA's Rapid Bioassessment Protocol II. The combined nine metrics, called the Macroinvertebrate Aggregated Index for Streams (MAIS) result in scores ranging from 0 to 18 (Smith and Voshell 1997). MAIS scores of 17-18 are "very good", 13-16 are "good", 7-12 are "poor/fair", and 1-6 are "very poor". The majority of the streams inventoried on the Forests (79%) fall into the "good" or "very good" category. These metric scores will be used as a tool for monitoring the effectiveness of the Forest Plan. Below is additional information about the individual nine metrics that make up the MAIS score.

Metric	Type of Metric	Description
EPT Index	Community Structure	The EPT Index is the total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. This value summarizes taxa richness within the insect orders that are generally considered to be pollution sensitive. EPT index decreases in response to increasing perturbation, and generally increases with increasing water quality.
Number Ephemeroptera	Community Structure	The total number of distinct taxa within the order Ephemeroptera. Mayflies are generally considered to be pollution-sensitive. Therefore, the number of mayfly taxa decreases in response to increasing perturbation.
Percent Ephemeroptera	Community Composition	The percent abundance of mayflies. Mayflies are particularly sensitive to a wide variety of impairments. This order is often missing in polluted streams.
Percent 5 most dominant taxa	Community Balance	The percent contribution of the five most numerically dominant taxa to the total number of organisms is an indication of community balance. A community dominated by a relatively few species would indicate environmental stress. This index generally increases in response to increasing perturbation.
Simpson's Diversity Index	Community Balance	Incorporates both richness and evenness in a measure of general diversity and composition. Diversity generally declines as impacts increase. Therefore, Simpson's index of diversity decreases in response to increasing perturbation.
Intolerant index	Tolerance	The number of macroinvertebrate taxa with tolerance values of 5 or less. Tolerance values taken from Family Biotic Index. Assumes that a greater percent abundance of intolerant macroinvertebrates indicates an unperturbed condition.
Family Biotic Index	Tolerance	This metric measures the proportion of sensitive to tolerant organisms in the community. The greater the proportion of sensitive organisms, the lower the index value. The greater the proportion of tolerant organisms, the greater the index value. This index generally increases in response to increase perturbation.
Percent Scrapers	Trophic	The relative abundance of scrapers in the riffle habitat provides an indication of the periphyton community composition. Scrapers increase with increased abundance of diatoms and decrease as filamentous algae and aquatic mosses (which cannot be efficiently harvested by scrapers) increase. Percent scrapers generally decrease in response to increasing perturbation.
Percent haptobenthos	Habit	Percent abundance of taxa requiring clean coarse substrate. Silty or scummy rocks are primarily inhabited by pollution-tolerant macroinvertebrates. Percent haptobenthos decrease in response to increasing perturbation.

Macroinvertebrate Monitoring Objective: Streams are managed in a manner that results in sedimentation rates that stabilize or improve the biological condition category of the stream as monitored using aquatic macroinvertebrates. Aquatic macroinvertebrates will be measured using EPA's Rapid Bioassessment Protocol II (EPA 1989), with modifications by Smith and Voshell (1997).

DIRECT AND INDIRECT EFFECTS

Currently, the biggest concerns for aquatic habitats on the Forest are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, impacts from roads, and acid rain. Ground disturbing management activities, particularly in the riparian areas, have the most potential for effects on fisheries and aquatic habitat resources on the Forest. Other threats include the removal of large trees that are located close to aquatic systems. These large trees provide shade, which aids in the regulation of stream temperatures. In addition, they are essential components in the continuous replacement of large woody debris to stream channels. Large logs and stumps create diverse habitat niches in streams vital to aquatic organisms.

Timber harvesting can directly affect sediment transport in streams if it increases (or decreases) the supply of sediment, if it alters the peak flow or the frequency of high flows, and if it changes the structure of the channel by removing the supply of large woody debris that forms sediment storage sites. Bank erosion and lateral channel migration also contribute sediments if protective vegetation and living root systems are removed.

If a forested riparian corridor were not left along the streams in a project area, reduction of streamside canopy could affect the physical characteristics of the stream channel and could also affect food quality and quantity for macroinvertebrates and other stream organisms directly and indirectly. Direct effects occur by changing the input of particulate food (leaf litter). Indirect effects come from alteration of the structure and productivity of the microbial food web through increased sunlight and modifying the levels of dissolved organic carbon and nutrients. Indirect effects of canopy removal may include increases in stream temperature. A 2-5^{o} C warming of small streams can affect life history characteristics of macroinvertebrates and developmental time of fish eggs (Sweeney 1993).

Roads affect the timing and volume of stream discharges by: intercepting and concentrating surface and subsurface flows; expanding or decreasing the channel networks; and reducing infiltration. The historic hydrological patterns within a watershed may be altered affecting the functions and processes to which the riparian and its inclusive aquatic communities have adapted. Roads located within the riparian corridor that either parallel or cross a stream present the greatest potential for allowing pollutants into surface waters. The use and construction of roads, log landings, trails, and other ground disturbing activities (including those associated with the development of wind energy that can increase erosion and sedimentation and concentrate runoff) could increase the amount of erosion during periods of high flow. Sediment loading in streams affects the aquatic fauna directly and indirectly. Direct effects include damage to gills and body surface by abrasion by suspended particles. Indirect effects come from a reduction in available dissolved oxygen, a reduction in suitable habitat due to substrate being covered with sediment, a reduction in pool volume, and the filling of interstitial spaces. These all affect habitat quality and complexity.

Large, human-built impoundments can alter flow regimes by changing the timing and quantity of instream flow below the reservoir. A decrease in water volume can lead to changes in channel morphology and an increase in water temperature. Increased flow below an impoundment can lead to channel scour and flow levels that disrupt the reproductive cycle of aquatic organisms. For example, high flows could wash away glochidia or juvenile mussels. Impoundments also affect dissolved and particulate organic matter in the water column and can change the natural temperature regime of a downstream river reach. These changes can affect the available food for aquatic organisms and create unsuitable thermal habitat. River habitat above an impoundment ultimately changes from a lotic to a lentic system.

Large, anthropogenic impoundments, as well as poorly designed road and trail stream crossings, can block fish passage thereby isolating upstream populations. Migration and movement of aquatic species are primarily restricted at road crossings by hanging culverts, high water velocity, inadequate swimming depth, or any combination of these three factors. Migration and movement barriers may be desirable (in rare cases) to protect a native species (brook trout) from a non-native competitor (rainbow trout). During watershed level analysis, the aquatic communities should be sampled above and below any culverts that could be barriers. Where the aquatic community above a culvert appears to have lost components, a decision should be made to either restock the unoccupied habitat through seining or electro-fishing or replace the culvert to facilitate natural movement back into the area.

The limiting factor for meeting the chemical desired future condition is atmospheric deposition, something the Forest Service cannot control. This effect will not vary by alternative. The only way to change the chemical condition of the streams is to mitigate acidification directly through addition of limestone, or indirectly through participation in the development of air pollution emission regulations.

Management activities, particularly in riparian areas, have the most potential for effects on aquatic and riparian habitat resources on the Forest. As previously stated, the biggest concerns for aquatic habitat are sedimentation, future sources of large woody debris for self-maintaining diverse habitat components, canopy cover to maintain water temperature regimes, acid rain, and aquatic organism passage. Prescription areas and riparian management activities vary by alternative. Table 3B4-4 shows by alternative the general riparian

approach for species sensitivity factors. An additional sensitivity factor of "riparian integrity" was added to display the differences in approach between alternatives.

Table 3B4-4. General Riparian Direction by Forest Plan Alternative

Species Sensitivity Factor	Forest Plan Alternative Measure	Alt A	Alt A1	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H & I
Riparian Integrity	riparian corridor width-perennial	66'+	66'+	100’	100’ [1]	66'+ [2]	100’	100’	100’
	riparian corridor width-intermittent	33'+	33'+	50’	50’ [1]	33'+ [3]	50’	50’	50’
	riparian corridor width-ephemeral			25’	25’		25’	25’	25’
Sediment	acres of soil disturbance	182	72	178-262	66	276-413	175-254	138-200	183-267
	filter strip zone-perennial	66-200'	66-200'	100-150’	100-150’	66-200'	100-150’	100-150’	100-150’
	filter strip zone-intermittent	33-100'	33-100'	50-100’	50-100’	33-100'	50-100’	50-100’	50-100’
	filter strip zone-ephemeral			25’	25’		25’	25’	25’
Habitat Complexity	LWD desired conditions -cold water	125-300	125-300	200+	200+	125-300	200+	200+	200+
	LWD desired conditions -cool water	75-200	75-200	200+	200+	75-200	200+	200+	200+
Temp-erature	shade strip width-perennial	66'	66'	100’	100’	66'	100’	100’	100’
	shade strip width-intermittent	33'	33'	50’	50’	33'	50’	50’	50’
	shade strip width-ephemeral			25’	25’		25’	25’	25’
Acid deposition	Treatment of acid streams with lime a priority?	yes	yes	yes	no	yes	yes	yes	yes
Passage	Total road system at end of 10 years, mile	1,834	1,823	1,660	1,521	1,763	1,653	1,633	1,659*

A1 represents the actual implementation level of the 1993 Revised GWNF Plan
[1] width is larger than 100 feet in source watersheds and by impaired streams
[2] 100 feet in aquatic threatened and endangered species watersheds and 66 feet in other watersheds
[3] 50 feet in aquatic threatened and endangered species watersheds and 33 feet in other watersheds
*The total miles of road system at the end of 10 years for Alternatives H and I is 1,657.

Riparian integrity, sedimentation, large woody debris, canopy cover, acid rain, and aquatic organism passage are addressed differently by alternative. They are addressed either by mitigation, a resource approach (active management to meet desired conditions), or a natural processes approach (limited active management).

Alternatives A and D use an approach that resembles current management. The riparian areas are managed as a separate prescription area based on ecological parameters (width determined by true riparian characteristics defined by soils, vegetation, and biota). The desired conditions for fisheries and aquatic habitats are defined and buffered from other management activities through defined shade strips, filter strips, and vehicle exclusion zones. Aquatic habitats and fisheries are sustained in a healthy condition. Timber harvesting occurs in the riparian area outside the 66' buffer. There are no standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. Alternative D implements the Federally Listed Mussel and Fish Conservation Plan in those 6th level HUC watersheds that contain the James spinymussel, where riparian widths would be wider than for the rest of the Forest

Alternatives B, E, F, G, H and I also use a resource approach where riparian areas are managed as a separate prescription area, but defined widths are based on maintaining the desired ecological conditions of the entire riparian area, not just aquatic habitat. Riparian and aquatic habitats are sustained in a healthy condition. Timber harvesting occurs in the core riparian area only when needed to protect or enhance riparian-dependent resources; it is not suitable for timber production. Tree removal can occur in the extended riparian corridor to meet objective of adjacent management prescription, although vehicles are excluded. There are forestwide standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. The forestwide desired conditions and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan. The riparian corridor will be managed to retain, restore, and/or enhance the inherent ecological processes and functions of the aquatic, riparian, and upland components within the corridor in these alternatives. These standards should have a beneficial effect on the communities and their associated species.

Alternative C uses a natural processes approach, identifying riparian areas as a separate prescription area as in B, E, F G, H and I; but excluding most management activities to attain desired conditions in riparian areas. The forestwide desired conditions and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan; however, many fish management activities such as stocking, habitat improvement, and mitigation for acid deposition are restricted or prohibited. Wetland areas maintained by beavers and identified as important beaver habitat will be protected and enhanced. Species that require management to maintain suitable habitat (such as brook trout in acidified streams) would decline.

Overall, aquatic habitats are included in Management Prescription 11-Riparian Corridors. Under this management prescription, riparian areas and aquatic resources are managed to encourage the processes that maintain or lead to desired conditions for fisheries and aquatic habitats. Riparian habitats and fisheries are sustained in a healthy condition. In most riparian areas, a slow progression toward a mature forest of more shade tolerant species occurs. More large woody debris is deposited into streams. Riparian vegetation protects and stabilizes the stream bank, preventing accelerated erosion (Miller 1987). In addition, trees falling in the channel produce log steps, which dissipate energy and reduce associated sediment production and movement (Swanson and Lienkaemper 1977). Vegetated riparian areas also increase shade cover and thereby reduce water temperature, and contribute allochthonous organic matter (e.g., leaf litter and woody debris), directly and indirectly influencing food availability and aquatic organism populations (Fischer et al. 2010); they act as buffers between terrestrial and aquatic ecosystems, slowing the velocity of water flow, which results in the deposition of sediment and nutrient loads prior to reaching the stream channel (Edwards and Williard 2010). A recent study in Virginia showed that streamside management zone buffers (7.6m to 30m wide) were all equally effective at protecting water quality from forest harvest sedimentation; most of the sediment that entered stream systems came from the concentrated flow from roads, skids trails, or firelines (Lakel et al. 2006). Following an extensive literature review of riparian buffers, Tiner (2003) recommends vegetated widths of 30 meters to maintain aquatic food webs. This supports the expanded riparian and vehicle exclusion zone widths found in Alternatives B, C, E, F, G, H and I. When projects are implemented with full consideration of the riparian management prescription and channeled ephemeral stream standards, no direct or indirect adverse effects to aquatic organisms or to the aquatic habitat that sustain them should occur. In order to verify that these standards are adequate, some ground disturbing projects will be monitored for: filter strip widths

(implementation monitoring); off-site sediment movement and aquatic invertebrate community composition (effectiveness monitoring).

CUMULATIVE EFFECTS

The area considered for cumulative effects includes the fifth-level watersheds within the Forest proclamation boundary, and the analysis includes the potential effects of Forest, state and private activities on the waters within and leaving the Forest. Cumulative effects address the environmental consequences from activities implemented or projected within the watersheds in the past, present and reasonably foreseeable future. The combination of activities on National Forest System, state and private lands can create an effect at a watershed scale that otherwise would not be perceived as a problem at the project or subwatershed scale. In addition to their natural variability, watersheds differ by their management history, ownership patterns, and the types and levels of contemporary management activity. The combination of natural variables, ownership patterns and management activities contribute to the cumulative effects that shape the current conditions of the aquatic ecosystems within the analysis area. Given the variability in watershed conditions, both natural and management related, the discussion of cumulative effects will be general in nature (Reid 1998).

The current watershed and aquatic resource conditions in the analysis area are a reflection of the cumulative effects of past and present actions. Streams are deficient in LWD largely due to historic logging activities, sediment levels are elevated due to past and present management activities, and the hydrology of the watersheds is altered due to past and present land uses. Future activities can contribute to these effects or alleviate some of the problems. On NFS lands, the reasonably foreseeable future actions are considered to be the continuation of existing programs such as timber management, roads, developed and dispersed recreation, gas and mineral development, grazing allotments, special uses, fish and wildlife management, and other activities. On a broad scale, the effects of future management on NFS lands may result in some localized effects, but overall should not contribute to any measurable downstream impacts. This is due in part to Forest Plan direction for the protection of soil, water, and riparian resources, the continued natural recovery of watershed conditions across the Forest, and the implementation of watershed, riparian, and aquatic restoration projects. The level of potential harvest, and its distribution across watersheds, should not result in any hydrologic effects at the fifth-level watershed scale. With the exception of areas where roads, trails, or other facilities cross channels, riparian standards and guidelines should maintain the current level of stream shading and LWD recruitment. Opportunities also exist to revegetate and restore areas of degraded riparian conditions.

One concern is that future ground-disturbing activities have the potential to contribute to existing sediment sources, primarily associated with the forestwide transportation system. Roads continue to be a chronic source of sediment and additional inputs may be detrimental to the health of aquatic ecosystems depending on the existing site-specific conditions. The recovery of disturbed soils can be relatively quick, which reduces the erosion potential following the disturbance. But sediment that enters a channel can remain in the system for years, even decades, depending on the level of inputs and channel characteristics. Potential new sources could be off-set, in part or wholly, by correcting existing problems and reducing current inputs.

The influence of NFS land on cumulative effects for waters draining the analysis area largely depends on the level of ownership. NFS lands average 24 percent of the fifth-level watersheds within the proclamation boundary, ranging from .75 percent in the Craig Creek watershed to 59 percent in Dry River-North River watershed. NFS lands are typically located in the higher elevations and headwaters, and the influence of state and private lands increases going downstream. In watersheds where NFS lands are limited, the influence of state and private activities is greater.

Assuming the activities on state and private lands remain relatively constant, existing watershed and stream conditions within those areas should persist in the foreseeable future. Watershed, riparian, and aquatic conditions are modified by roads, rural and agricultural developments, logging, mining, housing developments, and other activities. Direct impacts to aquatic habitats occur through road crossings and flood control efforts. Reduced riparian vegetation effects stream shading, bank stability, LWD recruitment, and channel stability. A wide range of ground disturbing activities result in soil erosion and sedimentation in streams.

Implementation of forestwide standards would minimize the potential effects of land management activities on NFS lands and the Forest's potential contribution to cumulative effects. The existing transportation system continues to affect aquatic resources and water quality, and foreseeable actions that improve road-related problems can reduce the potential effects and the contribution to cumulative effects. Foreseeable harvest activities have the potential to contribute to sedimentation and cumulative effects associated with conventional logging and road-related impacts. Future harvest activities also provide an opportunity to correct or reduce existing road-related problems and sediment source. Alternative C has the lowest potential for ground-disturbing activities associated with management activities, followed by Alternatives F, A, E, B, G, H, I and D. However, Alternative C also has the highest potential for un-mitigated impacts from acid deposition or other anthropogenic activities, because of the natural processes approach. Alternative A has the highest projected mileage of system roads at the end of 10 years, followed by D, B, G, H, I, E, F and C.

B4B - AQUATIC SPECIES VIABILITY EVALUATION

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR 219.19). For planning purposes, a viable population is one that has numbers and distribution of reproductive individuals to insure its continued existence and is well distributed in the planning area. USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. These regulations focus on the role of habitat management in providing for species viability. Supporting viable populations involves providing habitat in amounts and distributions that can support interacting populations at levels that result in persistence of the species over time.

Aquatic habitats are unique in that they are found in and adjacent to streams and lakes. The mobility of aquatic species is usually limited to these habitats. Habitat alteration is probably the major cause of decline of aquatic diversity in the South. Channelization, impoundment, sedimentation, and flow alterations are the most common physical habitat alterations associated with the decline of aquatic species (Walsh et al. 1995; Etnier 1997; Burkhead et al. 1997). Other human-induced impacts to aquatic species include pollution, introduced species, and over-harvesting (Miller 1989).

Species are tied to specific habitat; when this relationship is known, the amount of suitable habitat can be estimated. Plan direction was designed to address the key factors that maintain the physical, chemical, and biological aspects of suitable habitat on the Forest. Aquatic habitats on the Forest are protected, restored, or enhanced to maintain the ecological integrity of the system. However, habitat quality within a freshwater ecosystem is determined by activities within the watershed (Abell et al. 2000; Scott and Helfman 2001), both on and off National Forest System land. For administrative purposes these watersheds are described as 5th level hydrologic units (HUCs). The planning areas for aquatic species are 5th level hydrologic units or watersheds at the Forest Plan level.

AFFECTED ENVIRONMENT

There are hundreds of aquatic species found in the 29 5th level HUCs associated with the GWNF. It is impossible to determine viability for each of these individual species. As a surrogate, the viability of proposed, endangered, threatened, sensitive, and locally rare (TESLR) aquatic species are assessed and threat to their viability determined; as well as Management Indicator Species and Species of Management Concern. Other species with wide ranges are generally not at risk.

To determine effects to habitat of these species, the condition of individual watersheds was evaluated. Watershed condition is determined from the physical and anthropogenic interactions within the watershed. Ideally, watershed condition would be developed from stream surveys. However, the extent and detail required to address all watersheds, including private land, with stream surveys is not available. To address habitat condition at the watershed level it is necessary to derive values from geographic data. These values were compared among the watersheds and a condition or set of conditions was determined.

Viability Evaluation Process

SPECIES LISTS AND STRESSORS

A comprehensive list of aquatic and riparian species with potential viability concern was compiled for the George Washington National Forest; the species list and associated documentation is found in Section 3, Species Diversity in the Aquatic Ecological Sustainability Analysis (Appendix G). The list included those species found both on and downstream (within the 5th level HUC) from National Forest in the following categories:

- Species listed as proposed, threatened, or endangered under the federal Endangered Species Act,
- Species listed on the Regional Forester's Sensitive Species list,
- Species identified as locally rare on the National Forest by Forest Service biologists,
- Management Indicator Species and Species of Management Concern

There are a number of physical, biological and chemical factors that influence populations; a thorough discussion of the key habitat factors that maintain aquatic ecological integrity, along with current condition and trend, is found in Section 2, Ecosystem Diversity in the Aquatic Ecological Sustainability Analysis. The stressors addressed here relate to these key habitat factors and the anthropogenic change processes discussed in Section 2.4a, Disturbance Processes. They are specific to forest management activities and our potential to affect population viability. The primary concerns associated with land management activities are 1) increased sedimentation due to ground disturbing activities, 2) decreased habitat conditions and channel stability due to reduced recruitment of large woody debris, 3) increased stream temperatures due to reduced riparian vegetation and stream shading, and 4) fragmentation of habitat and isolation of populations due to passage barriers associated with road crossings. In addition to these land management factors, much of the Forest is underlain by geologic formations that are sensitive to acid deposition and streams in watersheds with poorly buffered geologic types are susceptible to acidic conditions.

The threat analysis evaluated the sensitivity of species to the different stressors (sediment, habitat complexity, temperature, acidic conditions, and passage). Sensitivity to the stressors was assigned for each species, based on the published literature and personal communications; where there was a lack of detailed life history information, the following assumptions are used to evaluate species sensitivity:

Sedimentation: Benthic organisms, or life stages, are susceptible to sedimentation and the filling of interstitial spaces that affect habitat and food supplies.

Habitat Complexity: Species that prefer pool habitat are more sensitive to a loss of channel structure and habitat complexity than riffle and run dwelling species. Large woody debris plays a greater role in forming habitat in smaller headwater streams than in larger main stem systems, so species occupying headwater streams are more sensitive to losses of LWD.

Water temperature: Cold water species are more sensitive to changes in stream temperature than the cool and warm water species that are more tolerant.

Acid deposition: At times, the literature referred specifically to a species' sensitivity to acidic conditions. These species have been identified as being acid sensitive, when in actuality all species are susceptible to low pH levels. We also assumed that species in headwater streams are generally more susceptible to acidic conditions than species inhabiting main stem rivers with broad drainage areas, along with those that occur in watersheds highly sensitive to acidification (see Section 3.4, Species Groups in the Aquatic Ecological Sustainability Analysis).

Passage barriers: Road crossings on small streams are more likely to create passage barriers and reduce the habitat available to headwater species than crossings on larger main stem streams.

The list of species, potential habitat on national forest, ranks, and sensitivity factors are found in Table H-4 (EIS Appendix H).

Overall, the potential of the Forest to influence population viability either positively or negatively is greater in the headwaters than the larger main stem rivers. Headwater streams are usually in closer proximity to Forest management activities and the relative influence of management on NFS lands typically decreases as the drainage area increases downstream.

WATERSHED CONDITION

Species sensitivity to the five stressors was compared with the condition of their respective watersheds to determine the threats to their persistence in the planning area. The watershed condition was assessed using metrics representing each of the identified stressors. The metrics were a compilation from geographic information layers. These layers include ownership, streams, roads, geology, and land use. The metrics and combinations of data used to determine the metrics are outlined in the following list of watershed measures; an expanded discussion and data sources are found in the Watershed Analysis for GW Plan Revision (Appendix 5) within the Aquatic Ecological Sustainability Report (EIS Appendix G), and EWAP (2002).

Stressor	Watershed Measure
Sedimentation	Percent High Erosion Potential
Habitat Complexity	Percent Forested Riparian
Temperature	Percent Forested Riparian
Acid Deposition	Percent High Acid Sensitivity
Passage barriers	Road Density

Aquatic Viability Determinations

Separate viability determinations were made for each watershed where a species occurs, because in many cases watersheds support separate populations, and because factors affecting viability can vary considerably from watershed to watershed. Viability outcomes from each species by watershed were determined by incorporating elements of species distribution, abundance, and sensitivities to environmental factors; watershed condition relative to the species' environmental sensitivities; and the national forest role in the watershed. Viability outcomes are:

Outcome A. Species is well distributed and abundant within watershed. Forest Service may influence conditions in the watershed to keep it well distributed. Likelihood of maintaining viability is high.

Outcome B. Species is potentially at risk in the watershed; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome C. Species is potentially at risk within the watershed; however, the extent and location of NFS lands with respect to the species is NOT conducive to positively influence the sustainability of the species within this watershed. Therefore, species viability in the watershed may be at risk.

Outcome D. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome E. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk. Forest Service ability to influence the species is limited. Therefore species viability in the watershed may be at risk.

An assumption inherent in the determination of population viability outcomes is that a viable population currently exists. Often, this could not be confirmed using the available information. If a species was reported within a watershed, the assumption was other individuals exist and habitat conditions occur within that watershed to support a viable population.

Viability Evaluation Results

A summary of stressors and viability outcomes by watershed for each species is found in Table H-3 (EIS Appendix H).

For the species that are in watersheds with a viability outcome B and D, the species are potentially at risk in the watershed because of one or more stressors; however, the species are actually on the Forest, and through riparian management prescription direction the Forest Service may positively influence conditions at those localized sites. Therefore, through proactive management where the species occur on National Forest land, the likelihood of maintaining viability in that watershed is moderate.

Watershed stressor and species viability associations are primarily a result of historical influences that have reduced distribution and abundance of some habitat elements and species populations. This viability analysis was based on the assumption that the riparian corridor width is that found in Section 2.6 Plan Components for Ecosystem Diversity, in the Aquatic Ecological Sustainability Analysis. In general, effects of proposed management strategies are small relative to historical impacts and future external threats. Risks to species viability are minimized by thorough riparian management prescription direction and standards, as well as applicable common standards.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Alternative Comparison

Viability outcomes by watershed were then evaluated in light of species sensitivities and Forest Plan Alternatives (see Table 3B4-4. General Riparian Direction by Forest Plan Alternative in the Fisheries and Aquatic Habitat Section), and assigned a rating of:

+, increased protection for aquatic and riparian habitat from current plan
-, decreased protection for aquatic and riparian habitat from current plan
o, no change in protection for aquatic and riparian habitat from current plan

Although ratings could vary between stressors in the same alternative, only one rating was given for each species and watershed based on the overall potential for change.

The changes to viability outcome by species, watershed, and Forest Plan alternative are found in Table H-5 (EIS Appendix H). A summary of the changes by alternative is below. The changes to aquatic species viability based on the additional stressor of gas drilling are found in EIS, Chapter 3, Section D Federal Oil and Gas Leasing Availability.

Table 3B4-5. Number of Species/Watershed Combinations with Increased (+), Decreased (-) or No Change (o) in Protection for Aquatic and Riparian Habitat from Current Plan

Change in Viability Rating	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H & I
Increased Protection (+)		150	131	9	150	150	150	150
Decreased Protection (-)			19					
No change (o)	150			141				

Riparian integrity, sedimentation, large woody debris, canopy cover, acid rain, and aquatic organism passage are addressed differently by alternative. They are addressed either by mitigation (protection from other management activities), a resource approach (active management to meet desired conditions), or a natural processes approach (limited active management).

Alternatives A and D use an approach that resembles current management. The riparian areas are managed as a separate prescription area based on ecological parameters (width determined by true riparian characteristics defined by soils, vegetation, and biota). The desired conditions for fisheries and aquatic habitats are defined and buffered from other management activities through defined shade strips, filter strips, and vehicle exclusion zones. Aquatic habitats and fisheries are sustained in a healthy condition. Timber harvesting occurs in the riparian area outside the 66' buffer. There are no standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. Alternative D implements the Federally Listed Mussel and Fish Conservation Plan in those 6^{th} level HUC watersheds that contain the James spinymussel; therefore this alternative has increased protection in 9 of the species/watershed combinations. The increased protection comes from widened riparian corridors, through recognition of channeled ephemeral streams, by avoiding activities that would increase sedimentation within those widened corridors, by prioritizing restoration and enhancement of water quality and aquatic habitat, and by providing the optimal aquatic habitat and water quality which cannot be ensured on private lands.

Alternatives B, E, F, G, H and I also use a resource approach where riparian areas are managed as a separate prescription area, but defined widths are based on maintaining the desired ecological conditions of the entire riparian area, not just aquatic habitat. Riparian and aquatic habitats are sustained in a healthy condition. Timber harvesting occurs in the core riparian area only when needed to protect or enhance riparian-dependent resources; it is not suitable for timber production. Tree removal can occur in the extended riparian corridor to meet objective of adjacent management prescription, although vehicles are excluded. There are forestwide standards for channeled ephemeral streams. Current fisheries management practices may be suitable such as stocking, lake fertilization, streambank stabilization, use of habitat improvement structures, and use of mitigation measures for stream acidification. The forestwide desired condition and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan. These alternatives have increased protection in all of the species/watershed combinations. The increased protection comes from widened riparian corridors, through recognition of channeled ephemeral streams, by avoiding activities that would increase sedimentation within those widened corridors, by prioritizing restoration and enhancement of water quality and aquatic habitat, and by providing the optimal aquatic habitat and water quality which cannot be ensured on private lands.

Alternative C uses a natural processes approach, identifying riparian areas as a separate prescription area as in Alternatives B, E, F, G, H and I; but excluding most management activities to attain desired conditions in riparian areas. The forestwide desired conditions and standards are consistent with the Federally Listed Mussel and Fish Conservation Plan; however, many fish management activities such as stocking, habitat improvement, and mitigation for acid deposition are restricted or prohibited. Species that require management to maintain suitable habitat (such as brook trout in acidified streams) would decline. Therefore, there is increased protection in most of the species/watershed combinations for the reasons previously stated, but decreased protection in 19 species/watershed combinations that involve high elevation, acid sensitive aquatic species, in watersheds with significant National Forest ownership and a large proportion of acid sensitive geology.

B4C – FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES

James Spinymussel

AFFECTED ENVIRONMENT

The James spinymussel was federally listed as endangered in 1988 (USDI Fish and Wildlife Service 1990). Historically, this species was apparently throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all the major upstream tributaries (Clarke and Neves 1984). The species remained widespread through the mid-1960s, but now appears extirpated from 90% of the historic range. Since 1990, James spinymussel populations have been found in three tributaries to the Dan River in Virginia and North Carolina, which is outside of the species' range known at the time of listing.

This species is found in slow to moderate currents over stable sand and cobble substrates with or without boulders, pebbles, or silt (Clarke and Neves 1984). Hove and Neves (1994) found James spinymussels in 1.5 to 20 m wide second and third order streams at water depths of 0.3 to 2 m. Seven fish hosts, all in the family Cyprinidae, have been identified (Hove 1990): bluehead chub, rosyside dace, blacknose dace, mountain redbelly dace, rosefin shiner, satinfin shiner, and stoneroller. Freshwater mussels are filter feeders taking organic detritus, diatoms, phytoplankton, and zooplankton from the water column. The following excerpt from Hove and Neves (1994) states the current thinking on threats:

"There are several anthropogenic and natural threats to the James spinymussel's continued existence. Nearly all the riparian lands bordering streams with the James spinymussel are privately owned. With more intensive use of the land, it is probable that water quality and habitat suitability will deteriorate. At present, the most detrimental activities include road construction, cattle grazing, and feed lots that often introduce excessive silt and nutrients into the stream."

The introduced Asian clam is also considered to be a threat to the James spinymussel and is beginning to invade several sites (Hove and Neves 1994).

Occurrences of the James spinymussel near the Forest include Potts Creek, Craig Creek, Pedlar River, Cowpasture River, Bullpasture River, Mill Creek, and there are historic records from the James and Calfpasture Rivers. In the Craig Creek watershed, the species is stable due to population(s) in Johns, Dicks, and Little Oregon creeks (near the Jefferson National Forest). The species appears to be extirpated in Potts Creek or at such low numbers that detection is extremely difficult. In the Cowpasture River watershed, population status in the Cowpasture and Bullpasture is uncertain with the population in Mill Creek stable (see Table 3B4-6, Watson 2010).

Table 3B4-6. Location and Status of James Spinymussel Populations in the James River Watershed.

Watershed	Tributary	County/State	Status
James River	Bullpasture River	Highland/VA	Unknown
James River	Calfpasture River	Rockbridge/VA	Extirpated?
James River	Catawba Creek	Botetourt/VA	Extirpated?
James River	Cowpasture River	Bath & Alleghany/VA	Stable?
James River	Mill Creek	Bath/VA	Stable
James River	Craig Creek	Craig/VA	Declining
James River	Dicks Creek	Craig/VA	Stable to increasing
James River	James River mainstem	Various	Extirpated
James River	Johns Creek	Craig/VA	Stable
James River	Little Oregon Creek	Craig/VA	Stable to increasing
James River	Patterson Creek	Botetourt/VA	Extirpated?
James River	Pedlar River	Amherst/VA	Stable
James River	Potts Creek	Monroe/WV	Stable
James River	Potts Creek	Craig & Alleghany/VA	Extirpated?
James River	Upper Potts Creek	Monroe/WV	Stable?

Despite extensive searches, no occurrences of the spinymussel have been located on the Forest (Watson 2010). The 14 miles of potential habitat modeled for this species in the Ecological Sustainability Analysis assumes all of the river mileage is suitable substrate, which is not probable; in all of the watersheds with spinymussels near the Forest, the occurrences are all on private land. The James spinymussel does occur both upstream and downstream from the Forest. Current Forest management provides for water quantity and quality that contributes to the persistence of mussel populations. The main avenues for the Forest to aid in this species recovery are through land acquisition, assisting in augmentation efforts, and working with landowners to protect streams and streamside habitat. Several isolated reaches of habitat on the Forest could provide sites for augmentation if the substrate were suitable. Working cooperatively with State biologists, university experts, and the US Fish and Wildlife Service, the Forest developed a pro-active conservation plan for federally listed fish and mussels in 2004. The standards and guidelines in the plan are implemented in 6th level HUC watersheds that contain listed fish or mussel species. The following watersheds on the Forest are covered by the Federally Listed Mussel and Fish Conservation Plan.

Table 3B4-7. Sixth Level HUC Watersheds on the George Washington National Forest Included in the Federally Listed Mussel and Fish Conservation Plan

6th Level HUC	Watershed Name
020802010403	Mill Branch-Potts Creek
020802010404	Cast Steel Run-Potts Creek
020802010405	Hays Creek-Potts Creek
020802010601	Wolfe Draft-Cowpasture River*
020802010602	Shaws Fork*
020802010603	Benson Run-Cowpasture River*
020802010701	Scotchtown Draft-Cowpasture River
020802010702	Dry Run*
020802010703	Thompson Creek-Cowpasture River*
020802010801	Mill Creek-Cowpasture River*
020802010803	Simpson Creek-Cowpasture River
020802011201	Rolands Run Branch-Craig Creek
020802011202	Barbours Creek*
020802011205	Roaring Run-Craig Creek
020802011302	Town Branch-Catawba Creek
020802020104	Hamilton Branch*
020802020105	Fridley Branch-Calfpasture River*
020802020106	Cabin Creek-Mill Creek
020802020108	Guys Run-Calfpasture River*
020802020506	Poague Run-Maury River*
020802030201	Lynchburg Reservoir-Pedlar River
020802030202	Browns Creek-Pedlar River
020802030203	Horsley Creek-Pedlar River

* No spinymussel occurrence in this watershed, but is found in downstream HUC(s)

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The decline and extirpation of most populations of the James spinymussel may be attributed to habitat modification, sedimentation, eutrophication, and other forms of water quality degradation. Restricted movement of host fish may also be a factor in the decline of this species. For populations of the James spinymussel on or near the Forest, potential management influences include sedimentation, altered flow, and blockage of host fish passage associated with roads and crossings. Forestwide and riparian standards will protect the James spinymussel and its habitat from sediment released during management activities. The expansion of riparian areas in Alternatives B, C, D, E, F, G, H and I will manage all riparian areas in watersheds that support James spinymussel in line with the Forests' Federally Listed Mussel and Fish Conservation Plan. Instream flow needs will be quantified and maintained to protect aquatic organisms when new water use authorizations are proposed. Prior to the stocking of any non-native species, the Forest coordinates with the appropriate State agencies to ensure populations and habitats of native species are maintained.

The Forest will manage and protect extant populations and historical habitats of the James spinymussel. Protection and active management will be implemented where the species is physically on or historically occurred on Forest lands. Protection, monitoring, and augmentation will be the primary recovery objectives. Actions will be taken in order to identify additional suitable habitat and restore fish hosts and mussels to areas

on Forest lands. Recovery objectives will include annual or bi-annual monitoring within Virginia of representative populations by qualified biologists for populations trend and habitat quality. Monitoring will include either search indices or transects depending on local conditions and mussel densities. Inventories of additional potential habitat will also be conducted.

A cumulative effects analysis should consider incremental impacts of actions when added to past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time. For this document, cumulative effects were analyzed through a two-part watershed analysis, which included resource assessment and management prescription (Reid 1998).

Throughout the planning process, the Forest evaluated watersheds using information including, but not limited to: Virginia Department of Environmental Quality 303d report for impaired waters; Virginia Department of Environmental Quality and Virginia Department of Conservation and Recreation 305b report on non-point source pollution; Virginia Department of Game and Inland Fisheries collection records; West Virginia Division of Natural Resources collection records and reports; local knowledge of forest recovery from past conditions; local knowledge of current watershed problems; macroinvertebrate, stream habitat, and water chemistry information; and geographic information system layers of land use, point source, road and mine locations. Through this resource assessment, the Forest evaluated cumulative watershed effects associated with land use practices at the 5th Hydrologic Unit Code (HUC) watershed level, and their effect on aquatic fauna and habitat.

Concurrently, the Forest carried out an interdisciplinary analysis looking at interactions between resources with a goal of managing riparian corridors to retain, restore, and /or enhance the inherent ecological processes and functions of the associated aquatic, riparian, and upland components within the corridor, while minimizing effects to aquatic and riparian resources from other activities. This was done through many meetings and discussions, which included not only multi-agency resource professionals, but members of the public as well. From this work, prescriptions, goals, objectives, and standards were developed in order to focus management on riparian, aquatic, and healthy watershed needs. They were designed to not only minimize adverse impacts to aquatic and riparian areas, but to maintain them as healthy, functioning systems.

Resulting from the careful development of prescriptions and standards, there should be beneficial effects on in-stream uses (including federally listed aquatic species) during the implementation of the proposed Forest Plan. These beneficial effects include, but are not limited to: watershed restoration activities, and road and recreation site maintenance, reconstruction, relocation, and/or closure/rehabilitation; control and management of livestock grazing will reduce sediment that is currently entering the stream system. Buffer zone filter strips will limit sediment produced by ground disturbing activities (including road construction, firelines, trails, livestock grazing, wildlife habitat improvements, prescribed and wildland fire, recreation development, and timber harvest) from entering a stream system. Management of streamside areas for riparian purposes and needs will increase large woody debris and shade. Stream crossings of roads and trails will allow the passage of desired aquatic organisms.

Any effects from management activities will be insignificant or discountable, therefore there will be no adverse direct or indirect watershed effects to the James spinymussel. Since it does not occur on the National Forest, the main avenues for the Forest to aid in this species recovery are through educating and working with landowners to protect streams and streamside habitat, and assisting efforts to identify additional suitable habitat and restore these species to historical habitats as appropriate. In some cases, acquisition of lands within the Forest's Proclamation Boundary may also be part of recovery actions.

B5 – FOREST HEALTH AND PROTECTION

Beginning about 18,000 years ago during the peak of the last major glacial period, the forest communities of the GWNF that we know today began to be shaped by global climate changes, indigenous human cultures, lightning, windstorms, beavers, large ungulates, and native insects and diseases. In the more recent past, European settlement and modern society have disrupted some of these natural processes (fire, beavers, and large ungulates) and introduced new disturbances like air pollution, gypsy moth, and hemlock woolly adelgid. The Southern Forest Resource Assessment (USDA Forest Service 2002) and the Southern Appalachian Assessment (SAMAB 1996) provide a vast amount of information regarding the history of native plant communities in the southeast. This section of Chapter 3 will focus on non-native invasive species, insects and diseases, wildfire suppression, and use of wildland fire. Other aspects of Forest Health such as age class and species diversity, as well as species composition, are addressed in the Ecological Systems section of this chapter.

Non-Native Invasive Species

A multitude of non-native invasive species including non-native plants, insects, and pathogens threaten the integrity of native ecosystems in the southern Appalachian area. The Chief of the U.S. Forest Service (USFS) has identified non-native invasive species as one of the four critical threats to USFS ecosystems. In the United States, invasive species are reported to be the second-most critical threat to conservation of biodiversity (Wilcove et al. 1998). The Southern Appalachian Assessment (SAMAB 1996: 109) discusses a number of non-native invasive forest pathogen and pest organisms that have or are currently affecting the GWNF. Insects and diseases of most concern for the purposes of this analysis include European gypsy moth, hemlock woolly adelgid, and southern pine beetle. Emerging pests of concern, but for which the potential to impact the GWNF is yet unknown, include the emerald ash borer, ramorum blight, and Thousand Cankers Disease. A new non-native invasive aquatic species found on the Forest since the last planning cycle is the diatom, *Didymosphenia geminata* (didymo).

Non-Native Invasive Plants

AFFECTED ENVIRONMENT

Non-native plants are known to occur across Southern and Central Appalachian forests, often accounting for 25% or more of the documented flora. While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. As defined in Executive Order 13112 issued February 3, 1999, an invasive species is one that meets the following two criteria: "1) it is non-native to the ecosystem under consideration and, 2) its introduction causes or is likely to cause economic or environmental harm or harm to human health."

The Plan objective is to protect native populations of plants and animals through the timely treatment of non-native invasive plant (NNIP) infestations and to prevent or reduce the spread of NNIP infestations to high quality natural habitats. In selecting treatment methods, minimizing effects to native species and natural communities is a priority.

One of the goals of both the George Washington and Jefferson National Forest Land and Resource Management Plans is to maintain and enhance the diversity of plant and animal communities of the Central Appalachians, favoring plant and animal communities that warrant special attention. Given the current distribution of NNIP infestation sites on the Forest, there is a need to implement a comprehensive and integrated program of NNIP control to protect the integrity of natural plant communities. The integrity of natural communities on the Forest will be compromised if NNIP infestations are allowed to continue to spread and invade previously unaffected areas. In addition, management of NNIP infestations sites will help slow the spread of NNIPs in the Southern and Central Appalachians by minimizing the degree to which the Forest is a source of infestations for surrounding lands, both public and private.

To fulfill the goals of Executive Order 13112, NNIP treatments are intended to be adaptive in nature and allow the use of integrated methods for the future treatment of invasive plant infestations.

The Forest recognizes that prevention is critical in NNIP management. Prevention includes educational efforts as well as Forest Plan standards that reduce the probability of NNIPs being spread by Forest management activities.

A list of the high priority invasive plant species across the Forest has been developed both from botanical surveys completed during the past 18 years and by consulting NNIP information provided by the Virginia Division of Natural Heritage, the Virginia Native Plant Society, and the West Virginia Division of Natural Resources. The exact infested acreage within the Forest is unknown and changes annually. Most of the 26 species identified in Table 3B5-1 are prevalent across the region and are continuing to spread, actively impacting biodiversity. A review of Forest field survey data from 2001 to 2010 indicated that 60% of the sites had one or more NNIP species present (Fred Huber pers comm.). These species were assigned a relative priority for treatment based on their known impacts on rare species and communities, their ability to rapidly spread, and their ability to persist in the forest. These species have been identified as the highest priority species on the Forest at the present time but the list will be updated as needed, based on new information regarding species' spread, invasion by new species, and infestation characteristics.

Table 3B5-1. Priority Species for Non-Native Invasive Plant Control

Scientific Name	Common Name	Invasiveness*	Ranking**	Priority‡
Ailanthus altissima	tree of heaven	1	77	1
Alliaria petiolata	garlic mustard	1	62	3
Buddleja davidii	butterfly bush	L	50	2
Berberis thunbergii	Japanese barberry	L	44	1
Carduus nutans	musk thistle	2	47	2
Celastrus orbiculatus	oriental bittersweet	1	71	1
Centaurea biebersteinii	spotted knapweed	1	67	3
Cirsium vulgare	bull thistle	2	49	2
Elaeagnus umbellata	autumn olive	1	73	2
Lespedeza cuneata	sericea lespedeza	1	46	2
Ligustrum spp.	Privet	1	50	2
Lolium arundinaceum	tall fescue	2	57	1
Lonicera japonica	Japanese honeysuckle	1	80	3
Lonicera maackii	Amur honeysuckle	2	65	1
Lonicera morrowii	Morrow's honeysuckle	1	65	1
Lonicera tatarica	Tartarian honeysuckle	2	65	1
Lythrum salicaria	purple loosestrife	1	73	1
Microstegium vimineum	Japanese stiltgrass	1	69	3
Paulownia tomentosa	princess tree	2	50	2
Perilla frutescens	beefsteak plant	3	40	1
Persicaria perfoliatum	mile-a minute	1	73	1
Polygonum cuspidatum	Japanese knotweed	1	55	1
Pueraria montana var. lobata	kudzu	1	52	2

Scientific Name	Common Name	Invasiveness*	Ranking**	Priority‡
Rosa multiflora	multiflora rose	1	78	2
Spiraea japonica	Japanese spiraea	2	44	2
Tussilago farfara	coltsfoot	L	60	3

* Invasiveness based on Virginia Department of Conservation and Recreation:
1=Highly Invasive;
2=Moderately invasive;
3=Occasionally invasive;
L=Locally invasive
**Ranking based on Hiebert and Stubbendieck 1993
‡ Priority: 1=high, eradicate wherever found
2=medium, control source populations and eradicate outliers
3=low, prevent invasion of last areas not invaded; eradicate high priority areas

Of the non-native invasive plant species found on the Forest, 26 species are particularly troublesome and are anticipated to make up the largest percentage (by acreage) of actual treatments implemented. Of these 26 species, 15 are listed as Highly Invasive by the Virginia Department of Conservation and Recreation, 7 are listed as Moderately Invasive, one is listed as Occasionally Invasive, and three are locally invasive on the Forest.

DIRECT AND INDIRECT EFFECTS

While not all non-native species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displacement of native plants; degradation or elimination of habitat and forage for wildlife; extirpating rare species; impacting recreation; affecting fire frequency; altering soil properties; and decreasing native biodiversity. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Infested areas represent potential seed sources for continuation of the invasion on neighboring lands. Alternative A follows the current Plan which is not as aggressive in controlling NNIP as Alternatives D, E, F, G, H and I. Alternative B only includes integrated pest management and is less aggressive at controlling NNIP than D, E, F, G, H and I. Alternative C would result in the least amount of ground disturbance which could reduce the potential for NNIP infestations; however, the decrease in accessibility could result in less aggressive treatment of NNIP infestations. Alternatives D, E F, G, H and I, all have similar language regarding pre-treatment of areas that will be disturbed. Therefore, the potential for NNIP infestations from ground disturbing activities could be offset by aggressive NNIP treatments.

Treatment options for NNIP include manual, biological, mechanical (e.g. mowing), and chemical (e.g. herbicide). While all control methods have an appropriate place depending on the site and plant targeted, we expect the majority of acres controlled to utilize herbicide. Herbicide use can result in non-target impacts to desirable plants, other organisms, and resources such as water quality. No use of aerial application of herbicide is contemplated under any alternative. Targeted applications such as cut surface, basal bark, and target foliar applications with a backpack sprayer will be the application method of choice. Broadcast spraying may be utilized in specific circumstances, such as roadside maintenance, or when treating plants that completely dominate a large area (e.g. fescue). Targeted applications greatly reduce the chance for non-target impacts (Marshall, 2001). Standard drift control measures such as applying large droplets, in low wind speeds, and higher relative humidity conditions also reduce non-target impacts, especially for the rare broadcast application.

Herbicide application has the potential to develop resistance of some plants to specific herbicides. This occurs when repeated applications of the same herbicide or herbicides using the same mode of action fail to kill the entire treated population. In time, this repeated treatment selects for plants that are resistant to the herbicide. This effect is most often noted in control of weeds on crop lands and is not identified as a common occurrence in forested situations (Weed Science Society of America, Managing Herbicide Resistant Weeds by State, http://www.weedscience.org/usa/statemap.htm). We do not expect resistance to herbicides to develop under

any alternative given the relatively low level of use as compared to cropland management of weeds. However, in the spirit of Integrated Pest Management, it is appropriate to incorporate certain mitigation measures into our herbicide treatments to guard against the development of herbicide resistance. Such measures include (source Herbicide Resistance Action Committee Guidelines for Herbicide Labels: http://www.hracglobal.com/Publications/HRACStewardshipGuidelinesforHerbicideLabels/tabid/604/Default.aspx)

1. Apply integrated weed management practices. Use multiple herbicide modes-of-action with overlapping weed spectrums in rotation, sequences, or mixtures.
2. Use the full recommended herbicide rate and proper application timing for the hardest to control weed species present in the field.
3. Scout fields after herbicide application to ensure control has been achieved. Avoid allowing weeds to reproduce by seed or to proliferate vegetatively.
4. Monitor site and clean equipment between sites.

CUMULATIVE EFFECTS

Left unmanaged, NNIP infestations will continue to spread, not only on National Forest System lands but potentially on adjacent private and other ownership lands. Even without active management NNIP infestations will occur across the Forest. Insect and disease outbreaks, wildfires, storm events (including wind thrown trees, flooding, landslides, and ice damage) encourage NNIP establishment. More areas of the Forest will be affected and the areas that are affected now will grow in size. Native species diversity and the integrity of natural communities will decline. Some threatened, endangered, sensitive or locally rare species may become extirpated from the Forest. Wildlife species will lose food sources and habitat structure will be modified. Plan alternatives that emphasize wilderness and limit accessibility will reduce somewhat the likelihood of NNIP infestations, but they will also reduce the ability to actively restore and maintain habitat using fire and timber management. Private land, state and federal roads, and streams adjacent to the Forest are all potential sources for NNIP to affect the Forest. It can be expected during the life of the Plan that development will occur near the Forest that will facilitate the spread of NNIP onto the Forest.

Didymo

AFFECTED ENVIRONMENT

Didymo (*Didymosphenia geminata*) is a freshwater diatom (type of alga) that historically was only found in pristine lakes and streams of northern latitudes. Its range is now expanding in North America to include lower elevation clear, cool streams. It can form massive blooms on the bottoms of streams and rivers where it attaches itself to the streambed by stalks. These stalks can form a thick brown mat that smothers rocks, submerged plants and other materials. Established mats form flowing streamers that can turn white at their ends and look similar to tissue paper. Although the alga appears slimy, it feels like wet cotton wool. Didymo was found in the Jackson River (GWNF) and Smith River tailwaters in Virginia in spring of 2006, the Pound River tailwater (JNF) in 2007, and Dan River in 2008. Information sheets were posted at Forest Service angler access points along the Jackson River to inform anglers and instruct them on how to prevent the spread of this invasive species. The Smith and Dan Rivers are not on or near National Forest System land.

DIRECT AND INDIRECT EFFECTS

Didymo colonization was monitored monthly over a 24 month period at a single transect in the Jackson River downstream of Gathright Dam to observe its growth over time. In 2008-2009, didymo density steadily increased from February–April, peaked in May-June, and then rapidly declined in the period from July–October. Transect scores were plotted against discharge, water temperature, and depth to evaluate relationships between alga density and non-biological factors. Positive, but weak, relationships were determined with all three criteria, but the strongest was between transect score and discharge. Biological response to didymo infestation was also examined by electrofishing and benthic macroinvertebrate monitoring before and after 2006. Post-infestation catch rates for wild rainbow trout (*Onchorhynchus mykiss*) in the Gathright Dam area were not significantly different than historic values (t0.05, 5 = 0.949). Stream metrics calculated for macroinvertebrates from the Gathright Dam area in 2007-08 showed a decline in ecological health from 1992-

93 samples. Results from this preliminary investigation indicated that didymo infestation has had a variable impact on aquatic fauna in one reach of the Jackson River Tailwater.

CUMULATIVE EFFECTS

Directly below Gathright Dam, the density of didymo varies by season from thick mats covering the stream bed during May-June, to a few scattered "buds" during the winter. Didymo has been observed at FS access points further downstream, but at much lower density, and has not developed into thick mats, even during the summer months. It is assumed that the water temperature is too warm and/or other factors keep the algae from surviving in the river past Covington. Didymo is currently unknown from other streams on the GWNF.

European Gypsy Moth

AFFECTED ENVIRONMENT

The European gypsy moth, *Lymantria dispar* (L.), is a major defoliator of deciduous hardwood forests. This non-native pest was first introduced from Europe into Massachusetts in 1869, and because one of the favored hosts (oak) is widespread in the eastern deciduous forests, it thrived and continues to expand its range west and south each year. By the 1980s, the gypsy moth was established throughout the Northeast (SAMAB, 1996). The generally infested, or quarantine area, extends from New England, south into Virginia, west to Ohio, and includes all of Michigan. The entire GWNF is considered generally infested by the gypsy moth and is wholly within the quarantine area. Meanwhile the gypsy moth continues to move southward.

The gypsy moth completes a single generation each year. First instar larvae (caterpillars) emerge from egg masses in April or early May. As temperatures increase, the caterpillars leave the egg masses during daylight hours and climb into the forest canopy. Upon reaching the tips of branches, larvae may spin down on silken threads and disperse on the wind. Most larvae are dispersed within the local area, but some may be carried for distances greater than twelve miles (Taylor and Reling 1986). Larvae may repeat this dispersal process several times before settling down to feed. Male caterpillars usually pass through five larval instars (or, growth stages) and females pass through six. Larvae usually complete their development by early to mid-June and seek a sheltered location for pupation. The pupal stage lasts about 2 weeks at which time the adult emerges. The male adult moth is dark brown and bears several black bands across the front wings and are capable fliers. The female moth is nearly white, with black bands across the front wings.

Females cannot fly but they can travel short distances from their site of pupation. This fact results in a relatively slow rate of natural spread of this pest. Females release a potent sex attractant (pheromone) to allure male moths for mating. Once mated, the female deposits her brood in a single mass of eggs and dies. The egg mass may contain from 75 to 1,000 eggs. Within four to six weeks, embryos develop into larvae within the eggs, overwinter, and hatch the following spring.

The gypsy moth's primary natural mode of spread over relatively short distances is by ballooning of first instar caterpillars on wind currents. The insect also may spread over much greater distances via human transport. Long distance spread occurs by two mechanisms, the transport of caterpillars or the transport of egg masses. People may pick up larvae in infested areas and carry them on their vehicles, belongings, or clothing to uninfested forested areas. The transport of the gypsy moth via egg masses occurs when vehicles, equipment, or household belongings infested with egg masses are brought into an uninfested area.

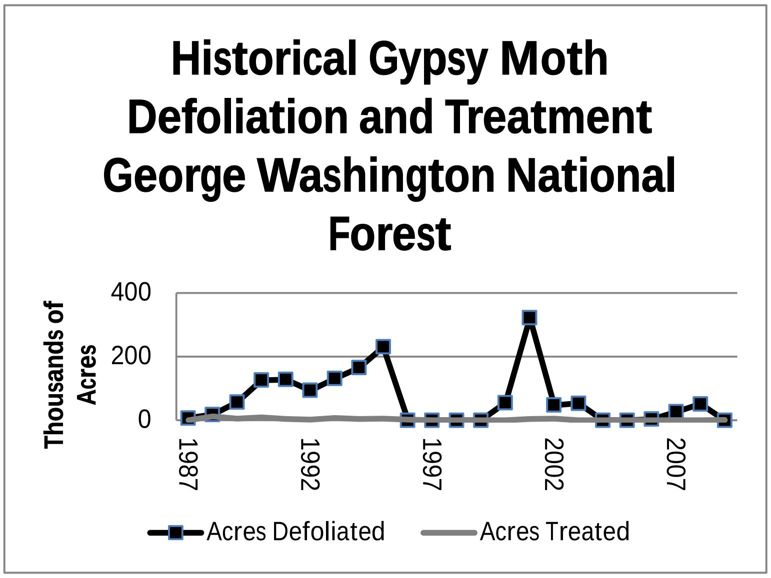
Gypsy moth larvae feed on more than 500 species of trees, shrubs, and vines. Favored hosts include oak, apple, birch, basswood, witch hazel, and willow. Hosts moderately favored by gypsy moth include maple, hickory, beech, black cherry, elm, and sassafras. Least favored hosts include ash, yellow poplar, American sycamore, hemlock, pine, spruce, black gum, and black locust. Late instar larvae can feed upon tree species that younger larvae avoid, such as hemlock, maple, pine, and spruce (Gansner and Herrick 1987). Feeding on less favored host plants usually occurs when high density larval populations defoliate the favored tree species and move to adjacent, less favored species of trees to finish their feeding and development. An individual gypsy moth caterpillar consumes the equivalent of approximately one square meter (10.75 square feet) of foliage during its development. A typical upland oak forest has 2.5 - 4.5 square meters of foliage per square

meter of ground surface area. Thus, the feeding of a relatively few, healthy caterpillars can result in severe defoliation of oak in a stand.

Defoliation by the gypsy moth may induce oak decline in healthy trees, resulting in reduced growth of shoots and stem, dieback of the crown, a failure in hard mast production, and a sufficiently weakened tree such that it is attacked and killed by woodboring insects and root disease fungi (Oak et al. 1991). Oaks in vigorous condition often can tolerate a year or two of defoliation before oak decline becomes pronounced. However, oaks that are stressed by pre-existing oak decline, drought, or some other factor tolerate defoliation less well. Tree mortality can be widespread and severe after a single defoliation under severe or compounding stress conditions. The damage caused by gypsy moth feeding in spring is harmful because trees must draw upon reserve carbohydrates and nutrients to produce a second canopy of leaves following defoliation (a process referred to as refoliation). Generally, a tree refoliates when approximately 50-75 percent of its canopy is consumed (Wargo 1979). Production of a new set of leaves following defoliation restores the photosynthetic capability of a tree's canopy; however, the refoliation process draws upon nutrient reserves that would be used for shoot growth and foliage production the following spring. The refoliated canopy is not able to fully replace the nutrients and stored reserves mobilized by the tree during refoliation, leaving the tree in a weaker condition the following spring. As a result, trees exposed to repeated defoliation and refoliation are weaker and more susceptible to attack by wood-boring insects and root-decay fungi.

Gypsy moth populations are cyclic. Generally populations build to epidemic proportions for a few years and then crash to low levels for a few more years. The entire cycle may range from three to ten years. At low densities, the gypsy moth is regulated, but not eliminated, by natural enemies such as parasitic insects and predaceous vertebrates, particularly small mammals. As populations increase beyond the control of these natural enemies, the gypsy moth is regulated by different mortality factors, primarily diseases and starvation. Of these two factors, diseases caused by the nucleopolyhedrosis virus (gmNPV) and the gypsy moth fungus (*Entomophaga maimaiga*) lead to the collapse of outbreak populations of gypsy moth. Generally speaking, the period between outbreaks may range from 2 to 5 years and the actual outbreak period may range from 1 to 3 years. On a region-wide basis, gypsy moth populations develop to outbreak levels across wide areas of the northeast, mid-Atlantic, and Lake States for a period of years and then drop to very low levels for several years. Factors regulating these regional outbreaks and collapses of gypsy moth populations are not well understood.

The first record of gypsy moth defoliation on the GWNF occurred in 1987. Since that time the forest has experienced 3 to 4 outbreak cycles with a total of about 1.5 million acres defoliated. Many areas have been defoliated several times resulting in severe mortality (Figure 3B5-1). However, no good estimate of acres within various levels of mortality has been attempted. In response to these outbreaks, the GWNF has participated in suppression efforts treating approximately 61,000 acres through aerial application of insecticides, primarily the biological insecticide *Bacillus thuringiensis var. kurstaki (Btk).*



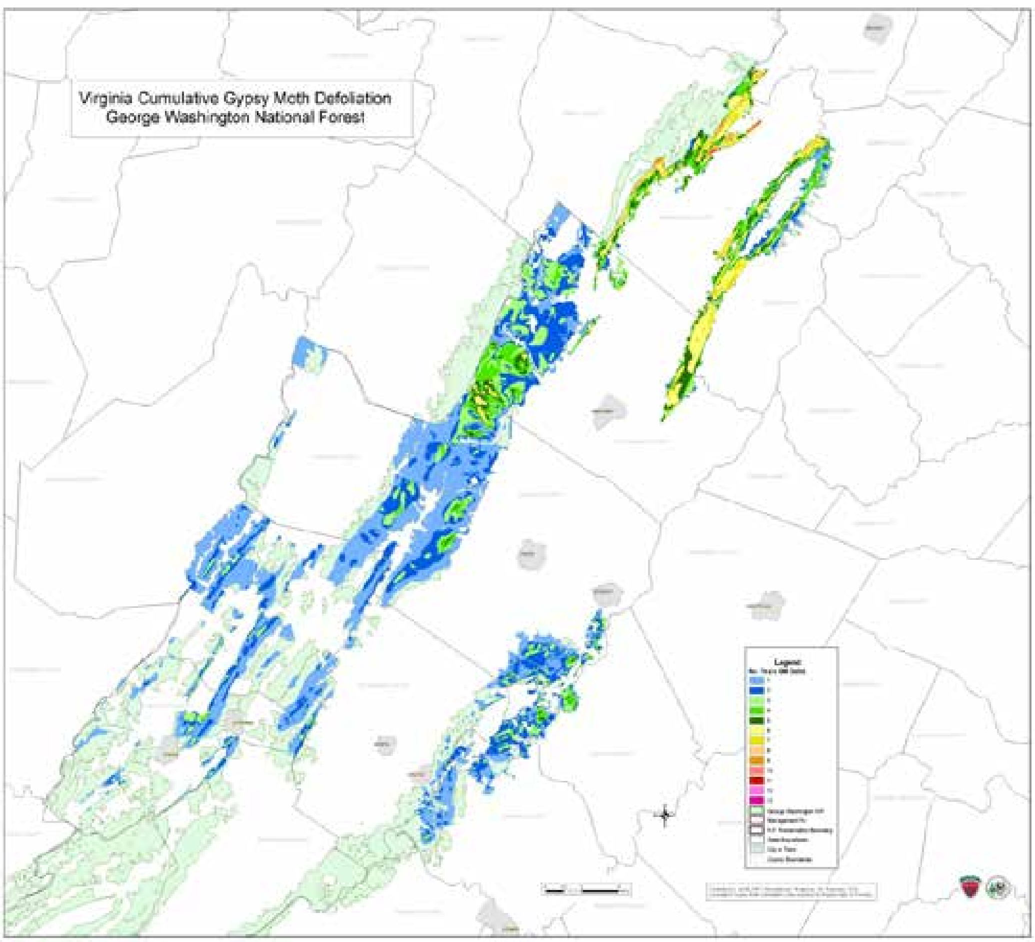


Figure 3B5-1. Cumulative Gypsy Moth Defoliation, George Washington National Forest

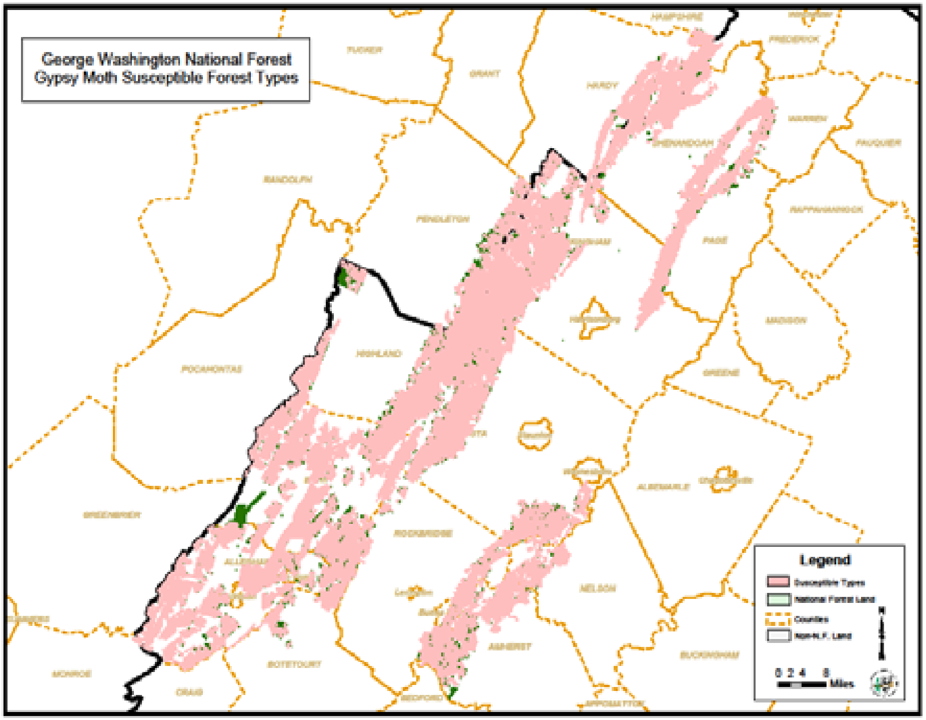


Figure 3B5-2. Gypsy Moth Susceptible Host Types

Approximately 867,000 acres of the GWNF is comprised of forest types susceptible to gypsy moth infestation (types where oak either dominates or is a significant portion of the stand). This represents approximately 72% of the forest in a moderate or severely susceptible host type. Figure 3B5-2 displays the distribution of these stands. As one would expect, the susceptible forest types are found evenly distributed across the entire GWNF.

A gypsy moth risk rating system has been developed for use with Forest Service Vegetation database (FSVeg) maintained by the GWNF. Entomologists at the Forest Health Protection field office in Asheville, NC developed this risk rating system. The model utilizes variables such as forest type, condition class, site index (a measure of site productivity) and age to assign a risk to each stand. Risks are categorized as Unaffected, Low, Moderate, High, or Extreme. This model was applied to the GWNF FSVeg information. Table 3B5-2 displays the existing condition pertaining to these gypsy moth risks.

Table 3B5-2. Number of Acres and Percent of the GWNF within 5 Gypsy Moth Risk Categories

Risk Category	Acres	Percent
Unaffected	280,500	27%
Low	78,000	7%
Moderate	65,000	6%
High	398,000	37%
Extreme	216,000	20%
Insufficient Data	28,000	3%

Thus, while almost one-third of the GWNF is currently considered to be at no risk (unaffected) from gypsy moth impacts, primarily by virtue of ineligible forest types (that is, they contain a predominance of tree species immune or not preferred by the insect), almost two-thirds of the Forest has a moderate to extreme risk of experiencing gypsy moth-related impacts.

DIRECT AND INDIRECT EFFECTS

While suppression of gypsy moth populations would be permissible under all alternatives, the economic cost and concern for environmental impacts of widespread use of current treatment tactics, primarily the aerial application of insecticides, would result in only a very small amount of the Forest receiving such management actions. Generally, gypsy moth outbreaks on most Forest lands will not be managed actively and population outbreaks will be brought to an end through the action of natural control agents (primarily by disease epidemics caused by fungal and viral pathogens). However, where high value resources, such as developed recreation areas, are threatened with defoliation and damage, treatment with insecticides may be considered to manage gypsy moth populations and limit damage. The impacts associated with such treatments are well documented in the Final Environmental Impact Statement (FEIS) for Gypsy Moth Management in the United States: A Cooperative Approach and in the Final Supplemental EIS (2012). This document and associated Record of Decision (ROD) analyzes the impacts of various aerially applied pesticides on control of the gypsy moth, impacts to non-target organisms, as well as impacts to human health. The FEIS and ROD indicate that the use of suppression, eradication, and slow the spread treatments fully meet the USDA goal of reducing the adverse effects of the gypsy moth, addresses the major issues associated with gypsy moth and their treatment, and provides the greatest amount of flexibility in managing ecosystems affected by the gypsy moth. Means to avoid or minimize adverse non-target impacts due to gypsy moth treatment are discussed in Chapter 2 of that FEIS and have been adopted. The findings from the FEIS are hereby incorporated by reference. It should be noted that such treatments do nothing to alter the risk associated with a vegetative condition; they merely control the pest.

Oaks are a favored host species and their density is a primary indicator of the susceptibility of a stand to gypsy moth defoliation (Gansner and Herrick 1987). Oak and mixed oak-pine forest types contain oaks at a high density and are therefore most susceptible to defoliation. Gypsy moth outbreaks may tend to be more frequent and the damage most severe where these stands occur in low-rainfall areas of the Forest. Hardwoods that are stressed by drought, oak decline, or some other factor tolerate defoliation less well (Witcosky 2000). Furthermore, outbreaks occurring simultaneously with severe spring droughts often lead to relatively high levels of mortality (>15% mortality following a single year of severe drought and defoliation; 30% mortality following 2-3 years of severe drought and defoliation). Long-term detrimental changes in forest composition and structure following gypsy moth outbreaks will be most frequent under conditions corresponding to high oak decline risk; stands with a large red oak component (especially black and scarlet oak) of advanced age growing on soils with low moisture availability. Outbreaks that cause defoliation for 2-3 years in a row will lead to more severe levels of damage to affected stands and outbreaks that recur in the same stand after very short intervening time intervals will lead to greater levels of damage. Mast production may be reduced or fail in affected oak stands during and following gypsy moth outbreaks (Gottschalk 1988).

As stated previously, factors that determine gypsy moth risk include forest type (oak density), site productivity (site index), age, and stand condition (condition class). Managers have no control over site productivity. Thus, species composition (forest type), stand condition, and age are the factors that managers can manipulate to alter the risk of gypsy moth impacts. Thinning and/or regeneration harvests can alter species composition and stand condition while only regeneration harvests can alter age of a given stand. Thus, our best tool in reducing the risk of receiving gypsy moth-related defoliation and/or mortality is vegetation manipulation through various types of timber harvesting and prescribed fire.

By modeling oak and oak-pine community types on the George Washington National Forest, we can obtain indications of how gypsy moth risk and active forest management actions interact. In the absence of management we can expect approximately 1% of the GWNF to move from a moderate to a high risk by the end of the first decade. The acres in a high or extreme risk category would increase by 27% to 84% of the Forest.

Harvesting of these stands in a timely fashion improves the risk of the stands in experiencing gypsy moth-related impacts. Harvesting can accomplish this goal through reducing the percentage of susceptible host types (primarily oak trees) and/or altering the stand condition (removing weakened or decadent trees) during a thinning or other partial harvest. Regeneration harvests also have this affect while reducing stand age, thereby increasing stand vigor and ultimately reducing the vulnerability of the stand to gypsy moth-related mortality in the event of a defoliation event (adapted after Gottschalk 1993.) In theory, managed fire may have similar results with stand replacing fires acting as regeneration harvests and less severe burning perhaps acting as a

thinning. The logical conclusion is that those alternatives that harvest and/or utilize prescribed fire on more acres in upland oak and mixed oak-pine stands will have a more positive impact on reducing gypsy moth risk. Table 3B5-3 displays the acres estimated to be regenerated in these forest types by alternative. Because fire is a less precise tool and it is difficult to predict acres regenerated or “thinned” through the use of fire, the effect of fire on gypsy moth risk is not quantified in this analysis.

Table 3B5-3. Estimated Acres Harvested within Gypsy Moth Susceptible Forest Types in the Next Decade and Acres of Moderate-High Gypsy Moth Risk at the End of the Next Decade, acres

Activity in Susceptible Types	Alt A	Alt A1	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H & I
Acres Regenerated	17,000	5,000	11,000	0	23,000	11,000	8,000	11,000
Acres Thinned	6,000	2,000	4,000	0	8,000	4,000	2,000	4,000
Total Acres Harvested	23,000	700	15,000	0	31,000	15,000	10,000	15,000
Total Acres Moderate – High Risk	599,000	617,000	607,000	622,000	591,000	607,000	617,000	607,000

A1 represents the actual implementation level of the 1993 Revised GWNF Plan

Based in part on the Desired Condition of the alternative, an estimate of the above management activities’ effects on the number of acres and percent of susceptible forest types within each risk category is presented. The focus of each alternative was used to estimate the percent of acres regenerated that would occur in each gypsy moth risk category. The base assumption is that the acres regenerated under each alternative would be equally distributed across all four gypsy moth risk categories. This assumption was then altered only for those alternatives where the focus would clearly change this distribution. For example, the focus of Alternative D is commodity driven and strives toward a balanced age class distribution and includes active control of insects. In this case, the total acres regenerated under Alternative D where allocated to acres of high and extreme gypsy moth risk. Conversely, Alternative F focuses on a variety of recreation opportunities and, in terms of forest health, emphasizes the maintenance of recreational experiences (e.g. user safety and visual quality). In this case the total acres regenerated were equally distributed across all risk categories.

Upon examining the results of Table 3B5-2 above, it is apparent that there is very little difference between the alternatives in altering gypsy moth risk after the first decade. The percentage of the oak and oak-pine community types in a high or extreme risk category range from 56% to 59% of the forest under all alternatives. Ten years is simply not enough time to seriously alter age class or species composition under any alternative.

Upon examining Table 3B5-4, we begin to see how the alternatives vary in their effect on gypsy moth risk at the end of 50 years of management. Alternative D would have the greatest impact with approximately 45% of the GWNF in a high or extreme gypsy moth risk. This is consistent with Table 3B5-3 above as Alternative D would regenerate the most acres of these susceptible community types. Alternative D would reduce gypsy moth risk better than any other alternative.

Table 3B5-4. Gypsy Moth Risk, percent

Risk	Alt A		Alt A1		Alt B		Alt C		Alt D		Alt E		Alt F		Alts G, H & I	
	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr	10 yr	50 yr
Low	7%	7%	7%	7%	7%	6%	7%	7%	7%	7%	7%	7%	7%	6%	7%	7%
Moderate	5%	5%	5%	5%	5%	3%	5%	5%	5%	5%	5%	5%	5%	3%	5%	5%
High	37	34	38	39	38	37	38	39	37	32	38	36	38	38	38	36
Extreme	19	15	20	20	20	19	20	21	19	13	20	17	20	19	20	17

A1 represents the actual implementation level of the 1993 Revised GWNF Plan

Alternatives A, E, G, H and I have a more moderate effect; approximately 49% and 52%, respectively, of the GWNF would be in a high or extreme gypsy moth risk. This is also consistent with the acres managed shown in Table 3B5-3 as these alternatives have a relatively high number of acres managed. Alternatives F, B, and C have less effect on gypsy moth risk; these alternatives range from 57% to 60% of the GWNF in a high or extreme risk category.

CUMULATIVE IMPACTS

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding gypsy moth risk are somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway) and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to be altered through vegetation management actions to any great degree. Thus, gypsy moth risk can be expected to increase slightly (similar to that modeled for the Forest without action) on these acres, where the proper forest type exists, for all of the reasons described previously. However, since these areas focus so heavily on recreation, they are likely to suppress gypsy moth populations on relatively more acres. Since lands administered by these agencies comprise a very small percentage of the area as a whole, such suppression is unlikely to have any effect on population dynamics of the general area. But, they may experience less gypsy moth-related impacts regardless of their vegetative condition simply due to repeated suppression activities on their lands.

Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation and is unlikely to receive a large amount of suppression efforts. Presumably, this area would be similar to the GWNF National Forest Alternatives B, E, F, G, H and I with respect to the ability to reduce the risk of gypsy moth.

Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Certainly those forested acres held by private industry are likely to be intensively managed and gypsy moth populations may be suppressed. However, as noted in the Timber Demand Analysis, very little industrial private forest remains in this area. Non-Industrial Private Forests (NIPF) account for almost 80% of the lands in the general area. The Timber Demand Analysis also found that perhaps as much as 55% of this land would not be available for vegetation management due to landowner attitudes and/or economic return. Perhaps increased gypsy moth activity may result in increased gypsy moth suppression activities and pre-salvage efforts ahead of defoliation as has been observed on some privately held acres. However, many acres of privately held lands would remain unmanaged and likely increase the risk of gypsy moth-related impacts.

Oak Decline

AFFECTED ENVIRONMENT

Oak decline is a complex native disease involving interactions between environmental and biological stresses and subsequent attacks by insects and pathogens of opportunity. The disease generally progresses slowly over several years. It begins with a long-term predisposing stress such as prolonged drought or advanced age. These stressed or older trees are often subsequently damaged by short-term inciting factors such as insect defoliation (e.g. gypsy moth), spring frosts, or acute drought. In their weakened condition, the trees may be attacked by insects and diseases that normally do not invade healthy trees. At this point, classic decline symptoms appear, beginning as dieback from branch tips inward and ultimately resulting in the death of the tree. The most important underlying factor when resource damage is severe may be a tree population dominated by senescent overstory oaks lacking vigor (Oak et al. 1991).

Oak decline is a serious forest health concern on upland hardwood forests in the Southern Appalachian National Forests. Stand and site factors that determine oak decline risk in the Southern Appalachians include forest type (oak density), site productivity (site index), age, and stress factors such as spring defoliation and drought or combinations of these stresses (Oak and Croll 1995). The highest risk conditions are stands with a large oak component (especially red oak of advanced age), growing on sites of average or lower productivity, with a recent defoliation history and prolonged growing season drought. Risk may be reduced by reducing

stand age through regeneration harvests, altering species composition through thinning (reduce or eliminate oak component), and/or preventing stress factors (treating spring defoliating insects with insecticides is the only feasible option but is often not economically justifiable).

Oak decline is so pervasive in the Southern Appalachians that no reasonable alternative can adequately address risk at the landscape scale in the short-term. Management actions can lower risk locally and sustained effort over the long-term can gradually lower risk on more area. Based on SAA analyses, the GWNF (along with the neighboring Jefferson National Forest) has the highest incidence of oak decline vulnerability and damage of all the Southern Appalachian Forests (SAMAB 1996). Indeed, Oak et al. (1991) found that approximately 30% of the oak forest types in the Northern Mountain Survey Unit of Forest Inventory and Analysis (FIA) data, which includes the GWNF, had oak decline symptoms. This area also had the highest losses due to oak decline ranging from 14 to 25 cubic feet per year. Vulnerability to oak decline refers to the probability that oak decline is expected to occur in a given stand. Approximately 288,000 acres of the GWNF is highly vulnerable to oak decline (chestnut oak stands), representing about 24%. Another 452,000 acres, or 33% of the GWNF, is moderately vulnerable to oak decline (oak-hickory stands). The remaining 475 of the GWNF is in forest types of low vulnerability. (Adapted after Oak et al. 1991)

DIRECT AND INDIRECT EFFECTS

There are a number of parallels between oak decline and gypsy moth impacts and our ability to manage them. For this reason, many of the conclusions and affects presented for gypsy moth above also apply to this discussion regarding oak decline. Like the gypsy moth, oak decline risk factors include forest type (oak density), site productivity (site index), age, and stress factors such as spring defoliation and drought or combinations of these stresses. Of these, managers have no control over site productivity and/or drought and little control over defoliating insects. Attempts to suppress insect pests over the entire, or even a significant part, of the landscape cannot be justified economically or environmentally. Thus, species composition (forest type) and age are the factors that managers can manipulate to alter the risk of oak decline. Thinning and regeneration harvests can alter species composition and only regeneration harvests can alter the age of a given stand. Thus, similar to gypsy moth, our best tool in combating oak decline is vegetation manipulation through various types of timber harvesting.

The ratio of site index (SI) to age can be used to estimate the vulnerability of an oak stand to oak decline. A SI/age ratio of less than 1.0 indicates a highly vulnerable stand and a SI/age ratio between 1.0 and 1.3 indicates a moderately vulnerable stand (Oak et al. 1991). Oak found that 60% of oak decline affected stands in western Virginia had SI/age ratios less than 1.0 and an additional 24% of the affected acres had SI/age ratios less than 1.4. However, the risk of mortality once a stand becomes oak decline affected appears to be higher in oak stands with an SI/age ratio less than 1.4. For the purpose of this analysis, we will consider stands with a SI/age ratio less than 1.4 to be vulnerable to oak decline and at a high risk for mortality if oak decline affected.

Regenerating these stands to a younger age class in a timely fashion reduces the risk of oak decline. This means that those alternatives that regenerate more acres in Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest Ecological Systems, especially in, black oak and scarlet oak stands, will have a more positive impact on oak decline risk and the preservation of related forest values such as wildlife habitat, recreation, and wood products. Table 3B5-5 displays the acres estimated to be regenerated in the vulnerable ecological systems and the acres at risk from oak decline effect at the end of the next decade by alternative.

Table 3B5-5. Acres in Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest Ecological Systems regenerated and at risk from oak decline effects at the end of the next decade by alternative

Activity in Susceptible Types	Alt A	Alt A1	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Acres Regenerated	20,200	5,000	25,300	0	38,600	15,200	8,400	22,800
Total Acres Vulnerable/High Risk	736,100	751,300	731,000	756,300	717,700	741,100	747,900	733,500

A1 represents the actual implementation level of the 1993 Revised GWNF Plan

Alternatives B, E, F, G, H and I have a more moderate effect on reducing oak decline vulnerability and risk; approximately 67% to 69% of the forest would be in a vulnerable and high risk of mortality to oak decline effects.

Alternatives D and A have the greatest effect on reducing oak decline vulnerability and risk; these alternatives range from 61% to 64%, respectively, of the forest in a vulnerable and high risk category. Alternative C would be expected to have the least impact as compared to all other alternatives on reduction of oak decline effects.

CUMULATIVE IMPACTS

In the description of the oak decline disease complex above, the role of both the long-term predisposing stress agent(s) and a short-term inciting agent was discussed. The entire GWNF experienced droughty conditions from 1999 through 2002 and most recently in the summer of 2010. This, coupled with the advancing age of our oak forests, results in an existing condition that is ripe for serious oak decline incidence. The potential consequences of this condition have been illustrated in recent catastrophic decline episodes in the Ozark-Ouachita Highlands of Arkansas and Missouri during the past five years (Starkey et al. 2004). The gypsy moth, an insect defoliator, has repeatedly defoliated several portions of the GWNF. More discussion on the gypsy moth and its impacts are disclosed elsewhere in this document, however it deserves discussion here as well. The gypsy moth is likely to be a short-term inciting agent that has and will continue to trigger oak decline events as populations of this insect continually cycle up and down. The combined effect of older aged oaks, past drought, and gypsy moth defoliation is likely to result in serious and widespread oak decline-related mortality of oaks.

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding oak decline risk are somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to be regenerated through management actions. Thus, oak decline risk can be expected to increase dramatically where the proper forest types exist as stands age without regeneration, for all of the reasons described previously. Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation. Presumably, these areas would be similar to the GWNF Alternatives B, E, F, G, H and I with respect to the ability to reduce the risk of oak decline.

Management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. Certainly those forested acres held by private industry are likely to be intensively managed and gypsy moth populations may be suppressed. However, as noted in the Timber Demand Analysis, very little industrial private forest remains in this area. Non-Industrial Private Forests (NIPF) account for almost 80% of the lands in the general area. The Timber Demand Analysis also found that perhaps as much as 55% of this land would not be available for vegetation management due to landowner attitudes and/or economic return. Perhaps increased gypsy moth activity may result in increased gypsy moth suppression activities and pre-salvage efforts ahead of defoliation as has been observed on some privately held acres. Both of these activities would result in a reduction of the risk of oak decline effects. However, many acres of privately held lands would remain unmanaged and likely increase the risk of gypsy moth-related impacts. Furthermore, the

encroachment of residences in the urban/wildland interface results in a desire to keep older oak trees intact for aesthetic reasons. Unfortunately, construction of house foundations in proximity to such trees often creates another stress through disturbance of the root zone. Often, such trees ultimately die unless care is taken in protecting them during construction. Therefore, the increase in residences encroaching on the GWNF is likely to result in more oak decline incidence in the general area.

Hemlock Woolly Adelgid

AFFECTED ENVIRONMENT

The hemlock woolly adelgid (HWA), *Adelges tsugae*, an insect species native to Asia, was first identified in the eastern United States in 1951 in Richmond, VA, but it has recently expanded into the Southern Appalachians and threatens to spread throughout the ranges of eastern and Carolina hemlock (USDA FS 2005). This non-native pest is currently established along the mountainous regions of western Virginia throughout the entire GWNF. The adelgid may be spread by wind, birds, or mammals (McClure 1990). Long-range movement of the adelgid by migrating songbirds in the spring could explain why northward spread has been faster than southward spread. Although individual stands of hemlock may not yet be infested by this insect pest, for all intents and purposes, the entire GWNF has been impacted by the HWA. A vast majority of hemlocks in the GWNF are in advanced stages of damage and widespread mortality is evident, although the number of acres of mortality and/or damage has not been estimated at this time.

There are two species of hemlock in the SAA area, eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*). Both species are included in the hemlock and northern hardwood forest community type. The former is an important component of riparian ecosystems, providing cooling shade for streams, contributing nutrients for streams through litterfall, and providing winter shelter for wildlife. It may also be important as a feeding and nesting niche for neotropical migratory birds (Rhea and Watson 1994). Carolina hemlock, on the other hand, is less understood ecologically and much less common on the GWNF. It generally occupies more xeric sites on ridges and rock outcrops, but it also probably provides cover and nesting sites for birds and small mammals. Both eastern hemlock and Carolina hemlock are threatened by the adelgid.

Approximately 8,000 acres of the GWNF is classified as containing a hemlock component, comprising less than 1% of the Forest. The highest concentration of the host type is located along the Blue Ridge and in the central portion of the forest on the North River Ranger District. The GWNF has been treating HWA infestation associated with a few recreation sites that still contained relatively healthy hemlocks in the late 1990s. These efforts focused on Brandywine campground in West Virginia and Hone Quarry and Todd Lake in Virginia. Originally an insecticidal soap was applied to the foliage annually. This treatment was abandoned in favor of the more effective soil injection of imidacloprid. These treatments have been effective in maintaining the health of these isolated hemlock stands. Meanwhile, a vast majority of hemlocks on the GWNF have experienced severe mortality.

DIRECT AND INDIRECT EFFECTS

Once infested by the adelgid, hemlocks are weakened, gradually lose their foliage, and are unable to refoliate or produce cones. Mortality occurs after complete defoliation, generally within 5 years of initial infestation (McClure 1987). There is no known genetic resistance to adelgids in either of the native Appalachian hemlock species, but resistance is known to occur in hemlocks native to Asia and in the two species native to the Western United States. Individual hemlock trees can be protected by spraying or soil treatments, but due to the advanced stages of decline and mortality found in a vast majority of hemlock stands on the GWNF, these treatments will not protect the trees. Except for those areas that have been protected in the past and a few isolated hemlock populations that have not yet been infested, it is simply too late to save most of the hemlock on the GWNF. It appears that all untreated hemlocks, with the possible exception of small geographically isolated populations, could eventually be killed by the adelgid. Loss of hemlock will negatively impact riparian ecosystems and may result in a substantial reduction in habitat quality for birds and other wildlife (Rhea 1995).

On the GWNF, both horticultural oil and imidacloprid (a soil injected insecticide) have been used to reduce adelgid populations and impacts on about 30 acres in three developed recreation areas. This treatment is likely to continue under all alternatives. Any healthy hemlock populations that may be found in the future may also be treated under all alternatives. Therefore, no substantial difference between the alternatives regarding treatment of or impacts from HWA is identified in this analysis. The impact of any treatment under any alternative is inconsequential to the landscape scale of this analysis. The extremely small areas treated have negligible influence on the impacts of the adelgid or hemlock forests on the GWNF.

Indirect effects may result in a loss of thermal insulation (summer cooling and winter insulation) along streams and riparian areas. In some areas, white pine may be able to fill this ecological niche, but it will take time for white pine to fully occupy the sites formerly held by hemlock. Loss of cover is likely to also adversely affect a myriad of bird and wildlife species on the GWNF.

CUMULATIVE EFFECTS

The situation described above can also be applied to surrounding lands held by private interests and other agencies. The adelgid infests hemlock regardless of ownership and active management or the lack thereof has no influence on the pest or its impacts on the host. The very sad fact is that hemlocks throughout the Appalachian mountains of Virginia will continue to deteriorate and die and there is very little anyone can do about it at a landscape scale at this time.

Southern Pine Beetle

AFFECTED ENVIRONMENT

Southern pine beetle (SPB) (*Dendroctonus frontalis*) infestations have occurred cyclically throughout recorded history in the South. This is a native pest. SPB outbreaks move from low levels of infestation to high levels over several years. The cycles may be localized or regional and depend upon weather and other stress factors as well as the interrelationship between the populations of SPB and its predators (SAMAB 1996e).

The female SPB kills pines and occasionally other conifers by boring under the bark and destroying the cambium layer of the tree. They construct winding galleries while feeding and laying eggs. During outbreaks, trees are usually mass-attacked by thousands of beetles. The crowns of trees attacked by SPB during warm, dry weather may fade in color within weeks. Once a tree is successfully attacked, the tree usually turns light greenish-yellow, then yellow, and finally reddish-brown. This color change pattern can vary depending on the tree and environmental conditions.

SPB outbreaks in the SAA area are generally less dramatic than those on the Piedmont and Coastal Plain of the south because yellow pine forests types are less common in the Appalachian Mountains (SAMAB 1996e). However, in rare instances, as occurred in the mid-1990s on the GWNF, SPB populations can build to such high levels that they attack and kill white pine. On the rare occasions when they do occur in the Appalachians, SPB outbreaks have significant ecological implications, not only because of the loss of relatively scarce habitat, but because at least one yellow pine species, table mountain pine, is largely fire dependent (SAMAB 1996e). Table mountain pine stands killed by SPB rarely regenerate, and are permanently lost.

Factors that determine SPB hazard include the proportion of the stand in susceptibility host trees (primarily the southern yellow pine species, although white pine can rarely be a susceptible species as well) and the radial growth of those trees over the past five years. Trees with a relatively high radial growth are less susceptible to SPB-related mortality (Mason et al. 1991). While we do not have individual tree radial growth data to estimate susceptibility, we can use the Culmination of Mean Annual Increment (CMAI) as a proxy for radial growth. Trees within stands that have passed beyond CMAI are growing relatively slower and radial growth should be slower. Previous modeling using the Forest Vegetation Simulator indicates that CMAI for the Yellow Pine working group ranges from 35 to 50 years old depending upon site productivity. For the purpose of this analysis we will consider stands equal to or older than 60 years old to be of a higher susceptibility to SPB. While thinning of these stands can increase radial growth and reduce SPB susceptibility, little or no thinning of yellow pine is implemented on the GWNF since most of these types occur on less productive lands.

Currently there are approximately 124,000 acres, or 12% of the GWNF, in the Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland ecological systems, without the white pine forest types. These ecological systems correspond to the host types susceptible to SPB. Of this acreage, approximately 118,000 acres, or 95% of the ecological system (without white pine types), are greater than 60 years old. Approximately 61,000 of these acres, or 49% of the ecological system (without white pine types), are greater than 100 years old. We conclude that for all intents and purposes, all of the Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland ecological systems on the GWNF are susceptible to SPB and roughly half of these systems are highly susceptible to SPB.

DIRECT AND INDIRECT EFFECTS

Managers can control both the proportion of susceptible species and the radial growth of trees through vegetation manipulation activities. Thinning and/or regeneration harvests can alter both species composition and radial growth of the trees within a stand. However, thinning in these stands that often occur on relatively poor sites is rarely economically, or even logistically, viable. Many of these stands occur on lands unsuitable for timber production. The use of prescribed fire can reduce stand density, much as a thinning would, and ultimately increase radial growth on the residual stems. Fire can also regenerate some forest types, especially table mountain and to a lesser extent pitch pine. Thus, while timber harvest can help to lower SPB risk, the use of prescribed fire can treat the most acres and represents our best tool in lowering SPB risk.

Table 3B5-6. Acres in Southern Appalachian Montane Pine Forest and Woodland and Central Appalachian Pine-Oak Rocky Woodland Ecological Systems burned, regenerated, and thinned and at risk from Southern Pine Beetle effects at the end of the next decade by alternative

Activity in Susceptible Types	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Acres Managed by Fire	3,000	7,400	16,000	10,000	12,000	70,000	16,000	70,000
Acres Regenerated by Harvest	2,000	300	700	0	3,000	1,500	1,000	1,500
Acres Thinned by Harvest	0	0	0	0	0	200	0	200
Total Acres Vulnerable/High Risk	114,000	111,000	102,000	109,000	104,000	48,000	102,000	48,000

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Between 39% and 92% of the ecological systems of concern would be in a SPB susceptible condition under the various alternatives analyzed given the objectives for prescribed fire and timber harvesting under each alternative. Alternatives E, G, H and I would reduce SPB risk the most as it is projected to utilize the most prescribed fire and any timber harvesting would be focused on ecological restoration and maintenance objectives. Alternatives B and F are ranked next highest in the number of susceptible acres due to a somewhat lower prescribed fire objective. Alternative D is not much different than B and F; in this case the greater timber harvest objective compensates somewhat for a lower prescribed fire objective. Conversely, because Alternative C allows for an expanded use of wildfire, it is projected to result in slightly less SPB susceptible acres as compared to Alternative A, which improves SPB susceptibility the least of all alternatives.

CUMULATIVE IMPACTS

When considering actions on private and other agency lands within or directly adjacent to the GWNF, cumulative impacts regarding SPB hazard is somewhat mixed. Lands administered by the National Park Service (Shenandoah National Park and Blue Ridge Parkway) and the Virginia Department of Conservation and Recreation (Douthat State Park) are unlikely to receive significant vegetation management actions. Thus, SPB susceptibility can be expected to increase dramatically where the proper forest types for all of the reasons described previously. Conversely, the State Wildlife Management Areas (Highland, T.M. Gathright, Little North Mountain, and Goshen) do receive a degree of vegetation manipulation. Presumably, these areas would be similar to the GWNF Alternatives B, F, G, H and I with respect to the ability to reduce the susceptibility to SPB.

Conversely, management actions on privately held lands vary quite a bit depending upon the objectives and beliefs of individual landowners. However, one commonality on privately held lands would be the very low use of prescribed fire and aggressive attack of wildfire. The role of fire in lowering susceptibility to SPB on these lands is expected to be negligible. Certainly those forested acres held by private industry are likely to be intensively managed and SPB outbreaks aggressively fought using timber harvest. However, many acres of privately held lands would remain unmanaged and likely increase in hazard of SPB outbreaks.

Emerald Ash Borer

AFFECTED ENVIRONMENT

The Emerald Ash Borer (EAB) (*Agrilus planipennis*) is an insect pest of recent concern for the GWNF. This non-native boring insect was first identified in the United States in 2002. Initial infestations were located in Michigan and Ontario, Canada. The insect has rapidly spread south and east and now occurs in Maryland, West Virginia, and Virginia. As of this writing, the nearest known infestations of EAB are located in Morgan County, WV, and Frederick, Fairfax County, Prince William, Pittsylvania, Halifax, Prince Edward, and Mecklenburg Counties in Virginia. EAB trapping has occurred in and around the GWNF since 2009; however no EAB have been detected as yet. Like the SPB, the EAB also feeds on the cambium of ash trees as larvae. It is the destruction of the cambial layer that disrupts the transport of water and nutrients up the tree and causes mortality. Unlike SPB, a single generation of larvae occurs in any given season, with the larvae overwintering in the sapwood of the tree. Beetles emerge in May or early June to mate and start a new cycle. At this time, only ash trees are believe to be susceptible to this species of borer. Infested trees decline over a few years and may die after 3 to 4 years of heavy infestation.

Ash is rarely a dominant tree in our forested stands with only about 100 acres of the GWNF being classified in a Forest Type containing ash species. However, ash species are often found as a minor component throughout the entire GWNF in the more mesic sites. While this insect pest is not likely to cause widespread severe mortality at the stand or landscape level because the host tree is not a dominant species in our Forest, it certainly could lead to severe decline and impact of ash species throughout the GWNF.

DIRECT AND INDIRECT EFFECTS

As there are few management actions or treatments identified that can prevent EAB susceptibility or risk, it is difficult to display differences in impacts amongst the alternatives. At this time the most effective activities in combating EAB on the GWNF involve continued detection, cooperating with enforcement of quarantines (administered by the Animal and Plant Health Inspection Service), and perhaps restrictions on the importation of firewood. We expect all these activities would continue under all alternatives.

In the event that an infestation is discovered on the Forest, removing the infested trees is about the only tactic that would prevent further spread. It is expected that all alternatives would utilize this approach. Perhaps the only difference between alternatives that can be expected is that this activity could be a commercial activity under all alternatives except Alternative C. For that reason, this activity may cost less to implement under all alternatives as compared to Alternative C.

CUMULATIVE IMPACTS

Unfortunately, we cannot be optimistic regarding this insect pest. The activities described above on the GWNF are likely to occur on all lands in the area regardless of ownership. However, despite these efforts in the past, new infestations of this pest continue to be found. It is very likely that this pest will continue to expand its range and mortality of ash trees in and around the GWNF is likely to increase despite any individual or agency action.

Ramorum Blight

AFFECTED ENVIRONMENT

Ramorum blight, also known as Sudden Oath Death Syndrome (SODS), is caused by the fungal pathogen (*Phytopthora ramorum*). This disease was first reported in 1995 in central California where it has caused widespread mortality in tanoak and oak species. The disease also manifests as a twig and foliar disease on many other species including members of the Rhododendron genus, including camellia species which prove to be a potential route of spread as infected nursery stock is moved around the country for ornamental landscaping purposes. *P. ramorum* has been confirmed in various states in the southeast, most recently in Greenville County, SC where a residential landscape site is confirmed to have a *P. ramorum*-positive *Rhododendro*n Sp. *'Catawbiense Boursault'*. No evidence of *P. ramorum* has been recovered from early detection surveys in Virginia. However, in the event that this organism is introduced to our forests, most likely through infected nursery stock utilized in surrounding areas, the GWNF would be at a moderate to moderately high risk for impacts from ramorum blight. Figure 3B5-3 displays a map of risk for ramorum blight (Kelley, et al. 2005).

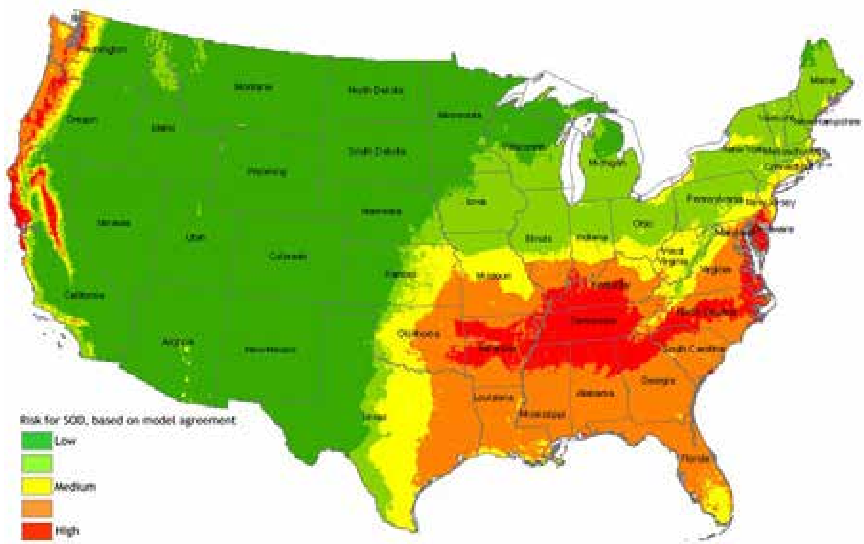


Figure 3B5-3. Risk for Sudden Oak Death in the conterminous United States: results from five spatially referenced models

DIRECT AND INDIRECT EFFECTS

Given the risk and the widespread occurrence of susceptible host types (oaks, rhododendrons, and mountain laurel) on the GWNF, there is a concern about the potential impact of this disease in our ecosystems. Unfortunately, very little is known regarding the potential impacts of ramorum blight here in the east or possible treatments to manage this disease at this time. No difference regarding the risk or treatment of ramorum blight is expected between the alternatives.

CUMULATIVE IMPACTS

Similar to the discussion above, there is a concern about the potential impact of this disease in our ecosystems. Unfortunately, very little is known regarding the potential impacts of ramorum blight here in the east or possible treatments to manage this disease at this time. We cannot identify any cumulative actions or activities that would combine with the GWNF activities to alter the impacts of ramorum blight.

B6 – FIRE - WILDFIRE AND PRESCRIBED FIRE

The presence of fire begins long before humans arrived in North America. Evidence of lightning fires exists as fusain in coal layers and as lightning scars on petrified trees (Pyne 1982). Even today, lightning and thunderstorms are abundant, and Pyne surmised, "A phenomenon of such magnitude and longevity has unquestionably kindled profound evolutionary consequences". This great and persistent selecting force has influenced ecosystem traits and characteristics since fuels and lightning first interacted. The result is a forest with diversity and flexibility that is well adapted to fire occurrence. Fire has no doubt been a major selection force in our forest ecosystems, both lightning and anthropogenic. Many communities and species require fire to sustain populations. Oak and southern yellow pine communities have been major components of these forests for thousands of years. These communities promote and require fire. Recurring fire has been a part of the ecosystem for thousands of years. Burning is the oldest sustained land management force on these forests. No other practice can be said to have such a track record with known results.

A clearer picture of change over time is gained when we focus on the period since the last ice age. Dramatic changes in plant and animal communities have occurred during this post-glacial period. Importantly, humans made their way onto the North American scene during this period. The ecosystems developed within the influences of both climatic and human forces. The question often debated is whether human ignition, for those thousands of years, should be considered when determining the “natural” state of ecosystems. Several points seem clear. The forests have been continually changing. The diversity and flexibility of these natural systems are necessary to react to change. Fire is an important mechanism to retain that diversity and flexibility.

Early human occupation of Virginia dates back to approximately 11,500 BP during the Paleoindian period (Barber 1996). European contact was relatively early in the region of the George Washington and Jefferson National Forests, Barber (1996) notes European contact did not occur in the Ridge and Valley area until the 1670s, and the written historical record of fire is rich with accounts from travelers and explorers. The obvious conclusion, common to each account, was the extensive use of fire by Native Americans. The effect, likewise, was extensive. Early observations describe vast areas of grassy savannas, commonplace smoke and fire, clearings and fields and apparent utilization of fire-managed vegetation (Maxwell 1910; Day 1953; Pyne 1982; Hammett 1992; Brown 2000). Maxwell contains a great number of accounts, but his perspective certainly reflects the bias and prejudices of the opponents to light burning. From all accounts, regardless of their perspective, burning by the Native Americans was a commonplace practice, serving many needs.

Methods of constructing fire histories in the east for pre-European settlement times have relied largely on sediment records (Craig 1969; Watts 1979; Patterson and Backman 1988; Patterson and Sassaman 1988; Wilkins et al. 1991; Kneller and Peteet 1993; Patterson and Stevens 1995; Delcourt and Delcourt 1996). These studies typically extract a core of sediment from a pond or bog, and that core is then sampled for pollen, plant macrofossils, and/ or charcoal.

Though a scarcity of suitable sites has limited the number of such investigations, ponds and bogs have provided a number of valuable sites in the Central Appalachians. Sites within or near the Forests are: Potts Pond (Watts, 1979) in Alleghany County; Hack (Spring) Pond and Quarles Pond (Craig, 1969), in Augusta County; Brown's Pond (Kneller and Peteet, 1993) in Bath County; and another study that includes Brown's Pond and also Green Pond, in Augusta County, near Sherando Lake (Patterson and Stevens, 1995).

Common to each study is the dynamic nature of the composition of plant communities. Climate is the determinant mechanism that propels this continuum of change along a geologic time scale (Patterson and Backman 1988). Fire acts within this continuum on a shorter scale, to provide an important catalyst that selects one plant over another. Watts (1979) agrees that this "migration of single species is an opportunistic response to changes in climate and environmental circumstances independent of other species". From 7,880 BP to the present, oak has been the dominant genus, comprising more than 50% of the pollen record. Pine is also present, increasing within this time period from 3% to 22%, with both white pine and yellow pines being represented. Chestnut stays below 1% until the upper, later half of the profile. The continued dominance of oak corresponds with relatively greater amounts of charcoal deposits. Blackgum was also found on Potts Mountain (Watts 1979) during this period. Watts had also noted an earlier rise in American chestnut at Potts Mountain.

Patterson and Stevens (1995) correlated charcoal surface area to pollen abundance, signifying the relative importance of fire for sampled time periods. Brown's Pond (Bath County) and Green Pond (Augusta County) were examined. Similar to other studies, they agree that the vegetation around Brown's Pond has changed little over the past 1,000 to as much as 4,000 years, with oak, hickory and chestnut representing important taxa. Also, ragweed was consistently present during this period, an indicator of agricultural activity.

Green Pond, on the other hand, showed a marked increase in total pine pollen, from <20% before the chestnut decline to over 40% more recently. Diploxylon pines (hard pines; i.e. pitch, table mountain, shortleaf, and Virginia) are more important than at Brown's Pond. Also of significance is the recent reduction in oak pollen since the chestnut decline, from > 40% to less than 30%, suggesting local vegetative changes.

They then looked at the amount of charcoal surface area found, relative to the pollen samples. At Green Pond, evidence suggests fire presence both before and after European settlement. They determined that fire had a significant impact on vegetation around the time of European settlement. Those high charcoal values are followed by a sharp increase in pine pollen. This charcoal peak was between the increase in agricultural pollen and before the chestnut decline. The data suggests that fire in early post-European settlement resulted in a dramatic change in vegetation.

At Brown's Pond, high charcoal to pollen ratios appear at 650 years BP, ~2,000 BP, and 4,210 years BP. The average ratio prior to European settlement is slightly higher than post-settlement, with two fires clearly evident since Euro-settlement. The higher pre-euro-settlement values indicate the long historical role fire has played in the hardwoods. The authors suggest that long interval fire regimes have been important in maintaining the vegetative composition typical of the central Appalachians.

Patterson and Sassaman (1988) compared amounts of sedimentary charcoal to archaeological sites and found that fires were common near larger Native American populations and where their land-use practices were greatest. Charcoal records prior to European settlement and post-settlement show little difference, except during the slash fires associated with the logging boom at the turn of the century.

These records clearly suggest that fires have been important in that area for the past 4,000 years, during a period of low lightning incidence. Human use of fire has been important in determining plant community composition (see also Sutherland et al. 1993).

Delcourt and Delcourt conclude by stating, "If management goals of the U.S. Forest Service include maintaining populations of fire-adapted pines and certain oak species that are currently declining because of active fire suppression, then future management tools clearly must include prescribed burning. The lesson from the Horse Cove example of prehistoric human use of fire is that fires of limited extent, focused on particular portions of the landscape, and excluded from others, can promote a heterogeneous mosaic of different vegetation types, some of which include clearly fire-adapted species, and others of which include fire-intolerant species. In order to maintain both old growth mesic hardwoods and fire-adapted pines within the same forest district, an optimal management plan would be based upon an understanding of the effects of different frequencies and intensities of fire applied to varying portions of the topographic-edaphic gradient and different areal extents of impact. Work of vegetation ecologists such as Runkle (1982, 1985) and Barden (1980, 1981) indicates that equilibrium, old growth mixed mesophytic forests will regenerate only under a disturbance regime that includes infrequent windthrow to open canopy gaps but which explicitly excludes fire (see also Clark and Royall 1996). Promotion of Appalachian oak forests, including relatively widely spaced oak groves or "oak orchards" with sparse understory of grass and bracken fern (Stephenson et al. 1993), on the other hand requires use of frequent ground fires such as may have been used by prehistoric Native Americans to maintain their hunting and gathering grounds. Furthermore, periodic crown fires along exposed ridge crests may be necessary for regeneration of fire-adapted endemic pine species".

The George Washington National Forest was established in 1918 and the national direction regarding fire was quite clear in the early days of the Forest Service (Pyne 1982)..."Forest fires have no place in any forest but as a result of ignorance, carelessness, and indifference (Anonymous 1936)". The practitioners of "controlled burning" battled against an enormous campaign set at the national level to stop all fire. With that new direction of suppressing all fires, that major force of selection that had been present since the ice age was suddenly altered. The consequences of that well-intentioned but misguided policy would not be obvious for several

decades. The selection process that influenced plant and animal communities now changed with the absence of fire.

Perhaps, though, in defense of the dedicated firefighters during these times, this is the way it had to happen. The use of fire-fighting equipment, intelligence, weather forecasts, budgets and fire behavior prediction have only recently enabled prescribed burning on a substantial level. Recent scientific literature regarding plant and animal reactions and effects are now better known. We have better data on pre-Euro-American settlement conditions. And now we are beginning to understand some of the more dramatic long-term impacts of fire exclusion, as plant and animal populations and conditions of forest ecosystems are altered.

Several other studies have approached the issue of fire occurrence, what it has been in the past and the implications of fire exclusion. Dendropyrochronology studies provide valuable information such as the season of fire occurrence since trees lay down early season and late season wood in each tree ring per year; the number of fire scars on an individual tree provides data on fire frequency; and, by cross dating fire scars on different trees that occurred in the same year one is able to approximate the spatial extent of a fire.

Sutherland and others (1993) sought to "reconstruct the historical relationship between fire and community structure using both the age and species composition approach in combination with tree-ring fire history analysis". Their study was one of the first in the Central Appalachians to use fire scars on pines to examine fire history. The study site on Brush Mountain in southwest Virginia west of Blacksburg, noted the loss of table mountain pine (*Pinus pungens*) recruitment since fire suppression in the late 1930s. Major recruitment of *P. pungens* occurred twice during the 1800s, probably due to exceptionally hot fires. The fire scar chronology indicated that fire occurred frequently (every 9-11 years) throughout the 19th century and early 20th century. Most of those fires occurred during the dormant season, most likely in early spring. The hot recruitment fires may have been during the growing season. They stated, "Fire suppression is most likely the cause of a dramatic change in the composition of the Brush Mountain communities during the last 60 years (Williams and Johnson 1990). In the past, fire clearly promoted integrity of the *Pinus pungens* community on Brush Mountain".

Subsequent fire history studies using dendrochronology at multiple sites and a larger sample size of scarred trees on both the GWNF and Jefferson National Forest found that the fire interval from the early 1700s to the 1930s ranged from 2 to 9 years (Aldrich et al. 2010; DeWeese 2007; Lafon and Grissino-Mayer 2005). Additional unpublished work by Aldrich has pushed this timeframe back to the mid-1600's which pre-dates European settlement in western Virginia. Work by Lafon in the southern Blue Ridge has found similar intervals for the same timeframe.

To examine fire history further back in time recent studies have examined and dated charcoal found in soil layers. A study on southwestern North Carolina found that fires burned regularly across the studied landscape for at least the past 4,000 years. These fires were not confined to the dry oak-pine dominated ridges but extended downslope into areas that are today dominated by mesic hardwood forests (Fesenmyer and Christensen 2010).

Wildfire Suppression

Fires generally fall into one of two categories: wildfires or prescribed burns. A wildfire is a fire resulting from an unplanned ignition; it usually requires a management response to control its spread based on resources at risk, fuel conditions, and predicted weather and fire behavior. A prescribed fire is any fire ignited by management actions to meet specific objectives. The term "wildland fire" is an inclusive term to refer to both wildfires and prescribed fires.

AFFECTED ENVIRONMENT

In a study of wildfire records on the George Washington National Forest, (Adams 1994) found that, between 1915 and 1993, there were 2,198 fire records on file. The vast majority (76%) were small fires less than 10 acres. Only 1% of the fires were greater than 1,000 acres. Early records, prior to 1950, are incomplete, but several significant trends can be determined. Nearly 40% of the fire starts were attributed to arson and smoking. An additional 14% were of unknown origin. Lightning accounted for approximately 14% of all fires

during that time period. Though this data is from in-service records of fire reports, it is assumed to accurately reflect trends in the data. The study also shows a typical spring and fall (April and November) fire season, attributed mostly to human starts. Lightning fires occur from the late spring through the summer with the highest months being May, July, and April (see Table 3B6-1). During the 20 year period, 1990 through 2010, lightning fires accounted for 25% of all fires while the remaining 75% were attributed to human causes, with arson accounting for 36% of the total fire workload. During that same period the statistics were nearly identical as what Adams had found, 73% of all fires were 10 acres or less and only 1% of all fires reached 1,000 acres in size or greater. Since suppression action was initiated on all the wildfires, there is no conclusive way to now accurately predict how large the fires would have become had suppression action not been taken. This information would assist in helping managers apply prescribed fire to the various forested ecosystems at levels to mimic the role of what naturally occurred.

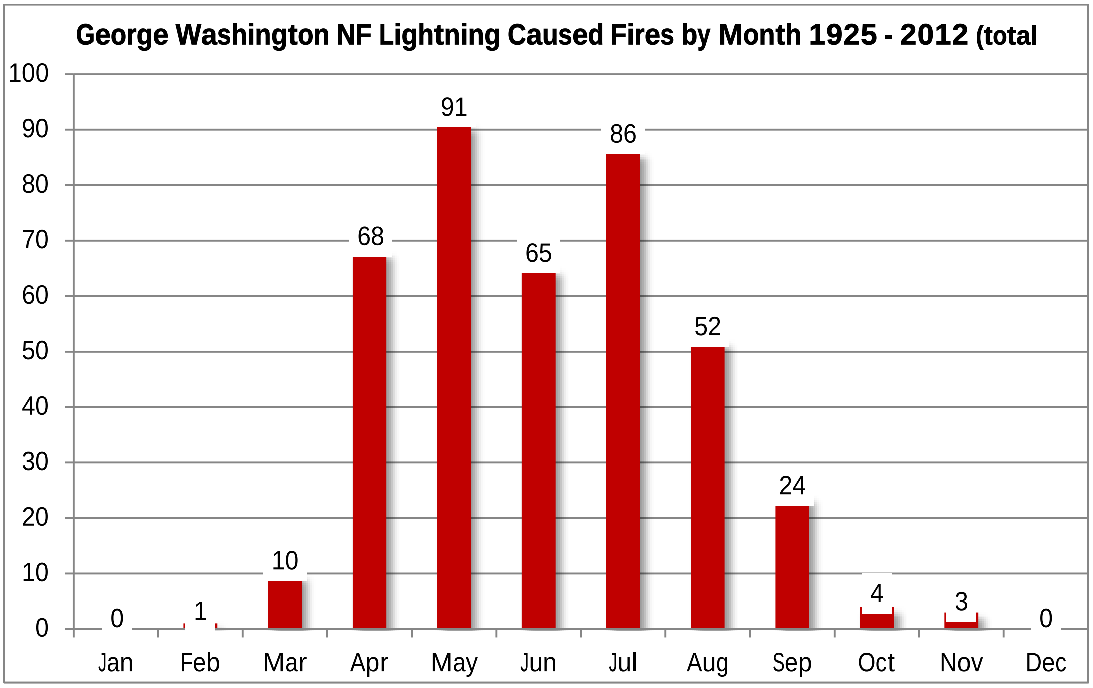


Figure 3B6-1. Lightning Fires

Fire is a random event and is therefore unpredictable as to its spatial occurrence. During spring and fall fire seasons, arson and carelessness is the leading cause of our human wildfire starts. Though we may know the area an arsonist is working, the next start is always an unknown. Law enforcement officials on the George Washington and Jefferson National Forests have been very successful in recent years in apprehending and prosecuting a number of arson cases on the forests that have led to prison sentences. We may be able to reduce, to a degree, human-caused fires through active fire prevention, education, and enforcement programs. The second leading cause of wildfire starts is lightning. Lightning is an extremely random event that is dependent upon the weather systems that occur.

Table 3B6-1 shows the wildfire history for 1990-2010 for both the George Washington and Jefferson National Forests. The largest lightning fire on the George Washington National Forest during the 21 year time period was 914 acres and occurred on the Eastern Divide Ranger District in June 2008. The largest human-caused fire during that same time period was 4,505 acres and occurred on the Glenwood Pedlar Ranger District in March of 2008. The average number of fires per year during the time period was 44 and the average acres burned were 2,441.

Generally, southern aspects had higher occurrences. Human-caused fires began largely on the lower slopes (following road and settlement patterns) and lightning was distributed on mid to higher slopes.

Volunteer Fire Departments (VFDs) gradually assumed the role of the local, less formal warden crews. VFDs are well-distributed through the valleys and are trained, equipped and quick to respond. Their rapid response has kept most roadside fires to minimal acres. Not all areas of the Appalachians have this committed response. VFDs have, no doubt, prevented many wildfires from involving homes and structures.

Table 3B6-1. Recent Wildfire History for the George Washington and Jefferson National Forests

Year	No. of Fires by Cause		Total	
	Lightning	Human	No. of Fires	Acres Burned
1990	3	44	47	1,197
1991	6	52	58	2,028
1992	3	20	23	408
1993	6	20	26	362
1994	12	50	62	572
1995	3	49	52	5,685
1996	2	20	22	89
1997	6	37	43	1,013
1998	2	59	61	2,754
1999	30	43	73	2,028
2000	16	43	59	2,126
2001	3	64	67	2,650
2002	28	3	61	5,426
2003	0	18	18	128
2004	4	14	18	213
2005	1	24	25	382
2006	11	25	36	6,813
2007	12	35	47	3,886
2008	10	37	47	10,750
2009	4	24	28	594
2010	14	35	49	2,162
Total	176	716	922	51,266
Average/Yr	8	34	44	2,441

The firefighting organization continues to evolve, as interagency and intra-agency cooperation multiplies available resources, communication improves, and aircraft is utilized. Firefighter and public safety is always the primary consideration for all suppression strategies and tactics. The full range of management responses from direct attack to monitoring a fire is available to the fire manager and line officer. Strategies and tactics for the fire should be commensurate with resource values at risk. Natural barriers such as rock slides, riparian areas, roads, etc. are used whenever possible to construct firelines to mitigate impacts to soil, vegetation and water; reduce costs of line construction; and to provide for additional safety considerations. The Fire Management Plan (FMP) is the implementation guide for the Fire Management program on the National Forest. The FMP describes in detail the fire suppression organization, the prescribed fire program, smoke management concerns and guidelines, the prevention program and all other relevant aspects of the Fire Management program.

The George Washington National Forest is relatively fragmented and therefore is adjacent to private land along much of its boundary. There is increasing pressure as additional growth occurs in these areas. More people desire to live in wooded surroundings and typically work at maintaining a natural vegetative state surrounding their property to provide a more isolated setting that will block the view of any adjacent structures. While this is aesthetically pleasing, the increased vegetation can quickly become hazardous fuel in the event of a wildfire.

From a suppression standpoint, anytime there is a wildfire in the wildland urban interface, more resources respond with a threat of structure involvement. These fires are much more expensive to suppress and are almost always multi-jurisdictional.

Wildfires occurring in the wilderness use MIST (Minimum Impact Suppression Techniques) techniques for fire suppression operations. Safety is still the primary consideration though when selecting strategies and tactics, tools and equipment, we utilize those that will have the least impact on the environment. Strategies that allow the fire to burn to natural barriers are favored and if fireline must be constructed, then it should be of a minimum width and depth to check fire spread. Limbing, bucking, and felling of trees or snags are minimized unless they are a safety hazard or threaten security of the fireline and then are only removed to a level to prevent additional fire spread.

Fuels Management

AFFECTED ENVIRONMENT

Recent research (Pyne 1982; Sutherland 1993; Hicks 2000; Hutchinson and Sutherland 2000; Kay 2000; Shumway et al. 2001; Schular and McClain 2003) and research recently completed (Lafon and Grissino-Mayer 2007) has shown the frequency and role that periodic fire (both human and lightning caused) has played in shaping the vegetation our landscape supports. Historical records indicate that Native Americans used low intensity fires in our area prior to European settlement and early European settlers continued this practice. Fire was used in efforts to drive game, but more importantly to improve wildlife habitat, maintain open meadows and grasslands, and clear undergrowth, especially in proximity to settlements (Pyne 1982; Van Lear and Waldrop 1989; Delcourt and Delcourt 1997, 1998). The woodland structure (open park-like understory) and tree composition (American chestnut, oak, & yellow pine) of these forests was long influenced and maintained by these fires. Ongoing tree-ring and fire scar studies being conducted in the mid-Appalachians (including western and southwest Virginia) indicate that from at least the early-1700s until the 1930s our forests burned on an interval of approximately three to ten years and that occasionally more intense stand-replacing fires occurred. Earlier than the 1700s, studies of charcoal deposits in pond and wetland sediments indicate fire has been common in our landscape for thousands of years. However since the 1930s suppression became the way all fires were managed. All wildfires were immediately suppressed regardless of cause and low intensity burning (commonly called light burning) methods were abandoned. All fire, both wildland and low intensity burning, was considered harmful to the forest. With seventy years of fire exclusion, forest structure and composition has, and is continuing, to change. Oak dominated forests are being replaced by more shade-tolerant species, such as white pine, red maple, and striped maple. Table mountain pine, pitch pine, and even oak (all fire-adapted and/or fire-maintained species) are in sharp decline over most of their natural range. Rhododendron, which should be located in moist north-facing drainages, is now encroaching onto upper drier slopes. Today, prescribed burning is used to mimic the early Native American, settler, and lightning caused fires.

For years 1993 through 2010, the George Washington National Forest (not including the Jefferson National Forest) prescribed burned a total of 89,577 acres ranging from a low of 170 acres in 1991 to a high of 10,156 acres in 2010. The 21-year average is 4,266 acres per year and the past 10-year average is 6,388 acres. Not all of these acres are separate and unique burns. Several of these prescribed burn areas have been burned two or three times during this period. Factors such as appropriate weather and fuel conditions, availability of equipment (e.g. helicopter, engine, dozer, UTV, etc.), availability of qualified personnel, ongoing wildfires, and funding play a critical role in determining how many acres are prescribed burned in any given year. Most prescribed burns on the George Washington National Forest are conducted between late February and early May. All prescribed burn projects must have a NEPA analysis completed and a burn plan prior to burn implementation. The burn plan contains specific burning objectives and parameters under which the burn will be conducted to meet specific resource management objectives.

Table 3B6-2. Number of Acres Prescribed Burned by Year 1990 – 2010 on GWNF

Year	Prescribed Burning
1990	1,092
1991	170
1992	970
1993	1,870
1994	795
1995	1,741
1996	1,339
1997	1,465
1998	6,564
1999	5,523
2000	4,172
2001	3,135
2002	2,322
2003	7,188
2004	7,103
2005	9,285
2006	4,914
2007	3,335
2008	9,563
2009	6,875
2010	10,156
Total	89,577

Prescribed fire is an important and ecologically appropriate management tool. Both natural fuels and artificially produced management-activity fuels must be managed over time to meet long-term resource management objectives. Artificially produced fuels have been of little concern, because of the small volume generated, but may have to be managed in the future. In a research burn conducted in the Blue Ridge Experimental Forest in Macon County, NC, (Clinton et al. 1998) more than 50 percent of the mass in litter and small wood was lost during burning. In this study, both fire intensity and severity were moderate. In addition to fire behavior, fuel size and flammability were important determinants of fuel mass consumption. Small wood is more completely consumed at lower temperatures than larger wood; plots high in wood mass in small size classes would lose more mass than plots with similar mass in larger size classes. Burning conditions that produce a more intense fire i.e. longer flame lengths with shorter residence times which equates to a lower severity fire with higher rates of spread would consume less of the humus layer and the associated nutrients though overstory mortality could become an issue dependent upon the type of commercial harvest method. Thus, this proves a strong case for using prescribed burning to treat the resultant slash from commercial harvest operations. Small logging slash, primarily in the form of foliage and fine branches, although temporarily dangerous as a fuel carrier in the case of an ignition, are a short-term problem, often decomposing within the first 4-5 years by white rot fungi in warm, moist environments according to Harvey and others. On the George Washington National Forest, logging contractors leave tops cut at 4” DBH left where the tree was felled and the rest of the logging slash is lopped and scattered to decay more quickly which consequently lessens the threat of a fire threat and distributes the fuel more evenly so if a fire did occur, or a prescribed fire were utilized to treat the slash, the fire severity would be lower and less intense. The EPA states, in their 1998 policy document entitled Interim Air Quality Policy on Wildland and Prescribed Fires, that while future air quality concerns from prescribed fire may arise, the EPA is on record stating that fire should function, as nearly as possible, in its natural role in maintaining healthy wildland ecosystems and to protect human health and welfare by mitigating the impacts of air pollutant emissions on air quality and visibility.

Fuels management considers both the dead and live fuel components within the fuel complex. These components vary widely across the forest according to ecosystems, insect and disease outbreaks, moisture or drought conditions, and the natural processes that occur without active vegetative management.

The dead fuel components are snags, dead pine needles and leaf litter, dead trees on the forest floor, and shrubs, forbs and graminoids that have fuel moisture low enough to be consumed in the flaming front of a fire. They comprise the available fuels and these values vary seasonally. Snags are becoming more of a hazard on the George Washington National Forest with the increasing incidence of gypsy moth, southern pine beetle and oak decline. Snags create a significant safety hazard during wildfire suppression and prescribed fire implementation.

Prescribed fire and mechanical fuels treatments are designed to reduce the risk of intense and unplanned wildfires by decreasing the amount of available fuel that the fire is able to consume and thus carry the fire. Both methods are utilized to restore fire regimes within or near an historical range. Since 2001 when the National Fire Plan (NFP) was implemented, there has only been one mechanical fuels treatment completed on the George Washington National Forest. A couple of reasons for the low number of completed mechanical treatments are the high cost per acre of the treatments, mechanical treatments are almost 10 times the cost of prescribed burning, most projects range in size from 20 – 70 acres in size so they are usually much smaller and are much more labor intensive hence the higher cost per acre. Examples of mechanical fuels treatments are lopping and scattering of branches of larger diameter trees, thinning of small diameter saplings and the mastication or mowing of large grassy openings.

Fire Regime Condition Class (FRCC), developed by the Forest Service with partners in nine other land management agencies and nongovernmental organizations, is a “standardized tool for determining the degree of departure from natural vegetation, fuels and disturbance regimes”. (For detailed information on this subject, visit http://www.frcc.gov). Agencies involved in developing the FRCCs were the Forest Service, National Park Service, U.S. Fish and Wildlife Service, The Nature Conservancy, U.S. Geologic Survey, Systems for Environmental Management, Bureau of Land Management, Missoula Fire Lab, and Bureau of Indian Affairs.

Condition Classes are a function of the departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, stand structure, successional stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of non-native invasive plant species, insects and disease (introduced or native), or other past management activities.

Fire Condition Class is a measure of general wildfire risk and ecosystem condition defined as follows:

Condition Class 1:

- Fire regimes are within or near an historical range.
- The risk of losing key ecosystem components is low.
- Fire frequencies have departed from historical frequencies by no more than one return interval.
- Vegetation attributes (species composition and structure) are intact and functioning within an historical range.

Condition Class 2:

- Fire regimes have been moderately altered from their historical range.
- The risk of losing key ecosystem components has increased to moderate.
- Fire frequencies have departed (either increased or decreased) from historical frequencies by more than one return interval. This results in moderate changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns.
- Vegetation attributes have been moderately altered from their historical range.

Condition Class 3:

- Fire regimes have been significantly altered from their historical range.
- The risk of losing key ecosystem components is high.
- Fire frequencies have departed from historical frequencies by multiple return intervals. This results in dramatic changes to one or more of the following: fire size, frequency, intensity, severity, or landscape patterns.
- Vegetation attributes have been significantly altered from their historical range.

There is a need to change the Fire Regime Condition Class (FRCC) on the GWNF from a FRCC 3 towards a FRCC 2 and eventually perhaps a FRCC 1 on as much of the Forest as possible. FRCC 3 is a condition of the landscape that is highly departed from its natural (historical) regime of vegetation characteristics; fire frequency, severity and pattern; and other associated disturbances. FRCC 2 defines a condition that has moderately departed from the natural (historical) regime and FRCC 1 defines a fire regime that is within the natural (historical) range of variability. The George Washington National Forest uses both prescribed fire and mechanical treatments to reduce fuel loading, to break-up fuel continuity (both vertically and horizontally), and to reduce rates of spread and therefore fire size, intensity, and severity. Nationally, the direction is to increase hazardous fuels treatment in the wildland urban interface areas. Those areas are the most expensive areas to suppress wildfires and pose the greatest threat to public and firefighter safety. Though there is not a one-to-one correlation between acres treated and suppression dollars saved or fewer acres burned, there is sufficient evidence to show that areas that have been treated typically exhibit lower rates of spread, less intensity, less severity, and a smaller final fire size under normal conditions.

In addition to prescribed fire, wildfire management includes the ability to utilize unplanned lightning ignitions by analyzing various parameters such as weather, fuel conditions and expected fire behavior to determine if the lightning fire is within prescription parameters so the fire could be purposefully used to meet prescribe fire management objectives.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Prescribed fire is also a valuable tool to provide wildlife habitat; for managing rare communities that require periodic fire to maintain plant viability; for pine species such as pitch and table mountain pine; for a silvicultural site preparation tool; for increasing forage; and for regenerating oak stands on productive sites (Brose and Van Lear 1999). Table 3B6-3 displays the acres of prescribed fire by alternative in an average year over the next decade.

Table 3B6-3. Prescribed Burning by Alternative

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Acres Prescribed Burned annually	3,000	7,400	12,000-20,000	Limited TES	5,000-12,000	20,000	12,000-20,000	12,000-20,000
Acres of Fireline (dozer)	2	5	8-13	0	3-8	13	8-13	8-13

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Alternative E would be the largest prescribed burn program since it has a strong focus on restoration. Alternative C would generate the smallest prescribed burn program as prescribed burning would be limited to managing TES species without an emphasis on ecosystem restoration. Alternative A has the acres estimated to be prescribed burned annually in the current Plan. Alternative D has an emphasis on commodity production and opportunities for prescribed burning are limited. Alternatives B, F, G, H and I have a program that includes an emphasis on restoration while taking into account fluctuations in weather and funding that may limit the number of acres likely to be burned annually.

Prescribed fire can have short-term negative effects on air quality. These effects may be mitigated by burning at certain times of the year, at certain fuel moisture thresholds, and under meteorological conditions that promote smoke dispersion. This information is provided in the burn plan that is prepared for each prescribed fire. A smoke management plan is required for each burn plan. More detail on smoke and air quality is provided in the Air Resource section of Chapter 3 of the EIS.

Prescribed fire can have positive and negative effects on non-native invasive plants. These effects may be mitigated by pre-treating NNIS to reduce the ability of that species to disperse and become established in the burn area and along control lines. After burning follow-up treatments can suppress or eliminate NNIS from the

area. This information is analyzed for each burn and addressed in the burn plan that is prepared for each prescribed fire. More detail on NNIS is provided in the Non-native and invasive species section of Chapter 3 in this EIS.

Our strategy for responding to wildfires is based on the ecological, social, and legal consequences of each fire. The circumstances under which the fire occurs and the likely effects on firefighter and public safety dictate the appropriate response and subsequent management. Wildland fires are unplanned natural ignitions that may be human-caused or result from natural storm events (i.e. lightning). All wildland fires are managed according to the prevailing Federal Wildland Fire Management Policy. All wildfires managed for resource benefits follow appropriate unplanned natural ignitions use, implementation procedure reference guides, and are assessed following a decision support process that examines the appropriate range of responses within the context of the LRMP. All alternatives will treat response to wildfire similarly; main factor that would affect response most notably would be the amount of Wilderness and the strategic differences in management.

SECTION C - SOCIAL AND ECONOMIC ENVIRONMENT

C1 - RECREATION

National Forests provide over 191 million acres of public land within the United States. National Forests in the Southern Appalachian region contribute approximately 4 million acres to the national total and provide unique settings for a variety of outdoor recreation activities such as primitive and developed camping, hunting, fishing, hiking, backpacking, horseback riding and off-highway vehicle driving, canoeing/kayaking and whitewater rafting as well as picnicking, sightseeing, nature watching, walking for pleasure and driving for pleasure.

Analysis Area

Market areas have been established for different national forests to better evaluate public demand for recreation opportunities. Past research has demonstrated that most national forest visits originate from within a 75-mile (1½ hour driving time) radius. Variation in preferences varies surprisingly little for broad population groups (i.e., age strata) across geographic areas. Therefore, the use of a market area provides a reasonable basis for assessment of recreation demand (*George Washington National Forest Recreation Realignment Report* Overdest and Cordell, 2001). For this analysis, the market area has been defined as all counties that fall within a 75-mile straight-line radius from the national forest border. For the George Washington National Forest (GWNF), the market area entails portions of Virginia, West Virginia, Pennsylvania, Maryland and North Carolina. The population living within the market area is about 10,544,000 (Source: U.S. Census Bureau 2010). Table 3C1-1 provides a summary of the cities, counties and population within the market area.

Table 3C1-1. Summary of States, Counties, Cities and Population within the Market Area for the GWNF

DC and States	Number of Counties & Cities	Population
DC	1	601,723
MD	9	2,705,547
NC	2	62,790
PA	6	428,305
VA	83	5,509,723
WV	32	1,236,481
TOTAL	131	10,544,569

Source: National Survey on Recreation and the Environment, Southern Research Station, US Census Bureau 2010.

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The most populated counties in the market area are Fairfax County, Virginia and Montgomery and Prince George's Counties, Maryland and then followed by Washington, DC. Other large municipalities within the market area include Alexandria, Arlington, Fredericksburg, Harrisonburg, Lynchburg, Manassas, Richmond, Roanoke, Staunton, Vienna, and Winchester, Virginia; Beckley, Bluefield, Elkins, Martinsburg and Princeton, West Virginia; and Frederick and Silver Spring, Maryland.

Opportunities for outdoor recreation within the market area are not limited to the GWNF. Within the market area, the U.S. Forest Service offers additional opportunities on the Jefferson and Monongahela National Forests. The National Park Service offers opportunities in Shenandoah National Park, Blue Ridge Parkway, Harpers Ferry National Historic Park, C&O Canal National Historic Park, multiple historic sites, and the National

Capital Region (mall, memorials and historic sites in Washington, DC). All of these areas connect and expand opportunities for recreation on federally managed public lands. The Appalachian National Scenic Trail also provides a unique long distance hiking opportunity north to south across the entire length of the market area. It connects multiple National Forests and Parks as well as State Forests and Parks from northwest Georgia to northwest Maine, with approximately one-fourth of its length being in Virginia.

A key finding of the Southern Forest Resource Assessment is that "of public ownerships, Federal tracts typically are large and mostly undeveloped. They fill a niche of providing back-country recreation. State parks and forests are usually smaller and more developed." (Southern Forest Resource Assessment, Chapter 11: Forest-Based Outdoor Recreation, H. Ken Cordell and Michael A. Tarrant, 2002.) Within the Commonwealth of Virginia, many state parks are located within a 75-mile radius of the GWNF border. Claytor Lake, Douthat, Fairystone, James River, Lake Ana, Shenandoah, Sky Meadows and Smith Mountain State Parks provide higher levels of development including overnight lodges and/or cabins. Smith Mountain Lake and Claytor Lake provide water-based recreation opportunities within the market area. West Virginia State Parks and Forests within the GWNF market area include Cacapon Resort, Lost River, Cass Scenic Railroad, Seneca, Watoga, Beartown, Greenbrier, Moncove Lake, Babcock, Bluestone and Pipestem. Likewise, a majority of these West Virginia State Parks and Forests offer highly developed recreation facilities.

The George Washington National Forest provides approximately 1 million acres of public land in the Valley and Ridge and Blue Ridge physiographic regions of western Virginia and eastern West Virginia. The Shenandoah Valley divides the George Washington National Forest into two separate sections. Each section provides a variety of unique recreation opportunities.

Recreation Demand & Trends

Recreation demand is a complex mix of people's desires and preferences, availability of time, range of price, and offering of facilities. The evaluation of current and future demand for recreation on the George Washington National Forest is based on recent surveys that identify and quantify:

- Estimated number of current recreation visits to the George Washington National Forest;
- Participation rates for recreation activities within the forest market area;
- Future activity demand based on projected population growth and shifts in demographics and income levels; and
- Activity demand by demographic strata.

The National Visitor Use Monitoring (NVUM) effort by the Forest Service has provided baselines for estimating current use of recreation sites. The 2001 and 2006 NVUM surveys data is not specific to each national forest, but rather the survey findings combined recreation use and activities for both the George Washington and Jefferson National Forests. The annual visits to the GWNF alone were estimated based on the percent of recreation sites, trailheads and access points included in the sites inventory for the 2006 NVUM that are on the GWNF. The estimated annual visits provided in Table 3C1-2 only account for people engaging in recreation activities; they do not include the millions of people that drive through the national forest without stopping to recreate, unless they did so for the purpose of viewing scenery.

Table 3C1-2. Fiscal Year 2006 Estimated Recreation Use on the George Washington National Forest

Type of Recreation Sites	2006 Total Annual Estimated GW & Jeff Site Visits*	2006 Total Annual Estimated GWNF Site Visits*	2006 Percentage of Total Estimated National Forests Site Visits*
Day-Use Developed Sites	399,800	202,200	19.5%
Overnight-Use Developed Sites	212,800	102,300	9.9%
Wilderness	47,100	11,200	1.1%
General Forest Areas	1,010,300	721,600	69.5%
Special Events and Organizational Camps	4,200	Not estimated	0.0%
Total Estimated Site Visits	1,674,200	1,037,300	100.0%

Source: National Visitor Use Monitoring Results, Data Collected Fiscal Year 2006, Report Last Updated March 2009.

*Site Visit is defined as the entry of one person onto a National Forest site or area to participate in recreation activities for an unspecified period of time.

Based on this NVUM data, the "developed recreation" day and overnight use areas combined makes up almost one-third of the estimated recreation site visits on the GWNF. Approximately two-thirds of recreation site visits can be defined as "dispersed recreation" that occurs away from developed sites in general forest areas and designated Wilderness. About one-third of 1% of recreation site visits are attributed to organized special use events and camps that occur in both developed and dispersed recreation settings.

People within the defined market area for the GWNF engage in a variety of recreation activities. Table 3C1-3 lists the types of activities ranked in order from highest to lowest participation rates based on the 2000-2004 National Survey on Recreation and the Environment (NRSE), an on-going national telephone survey sponsored by the U.S. Forest Service. The data here is specific to participation in activities in which the market area population engaged, although the activities may or may not have occurred on the George Washington National Forest.

Table 3C1-3. Types of Activities in Which the Market Area Population Engages (On and Off National Forest System Lands)

Recreational Activity	Market Area Survey	
	Percent	# of People*
Walk for pleasure	87.7%	6,303,054
Family gathering	75.2%	5,405,870
Visit historic sites	64.0%	4,602,377
Visit nature centers, etc.	63.7%	4,581,037
Picnicking	63.3%	4,551,409
View/photograph natural scenery	63.2%	4,545,428
Driving for pleasure	61.3%	4,406,426
Sightseeing	60.3%	4,332,833
View/photograph other wildlife	48.8%	3,510,264
Swimming in an outdoor pool	48.6%	3,489,977
View/photograph wildflowers, trees, etc.	48.3%	3,471,564

Recreational Activity	Market Area Survey	
	Percent	# of People*
Visit a beach	47.5%	3,416,639
Swimming in lakes, streams, etc.	45.4%	3,260,576
Bicycling (any type)	42.9%	3,083,258
Boating (any type)	38.8%	2,789,632
Day hiking	38.3%	2,751,542
Visit a wilderness or primitive area	35.2%	2,532,350
View/photograph birds	33.3%	2,392,019
Snow/ice activities (any type)	32.1%	2,307,625
Visit a farm or agricultural setting	30.5%	2,194,107
Gather mushrooms, berries, etc.	29.9%	2,150,416
Visit other waterside (besides beach)	29.1%	2,092,235
Freshwater fishing	25.2%	1,809,067
Visit prehistoric/archeological sites	25.2%	1,810,139
Mountain biking	25.1%	1,800,834
Motorboating	22.2%	1,592,503
View/photograph fish	22.1%	1,591,664
Developed camping	21.9%	1,571,514
Warmwater fishing	19.5%	1,399,697
Drive off-road	19.2%	1,379,365
Coldwater fishing	14.1%	1,009,775
Primitive camping	13.3%	959,277
Saltwater fishing	11.6%	831,240
Hunting (any type)	11.5%	827,106
Canoeing	11.3%	809,605
Backpacking	10.9%	781,897
Downhill skiing	10.5%	754,489
Rafting	10.3%	743,500
Big game hunting	10.1%	728,982
Horseback riding (any type)	9.5%	682,560
Sailing	8.5%	609,380
Use personal watercraft	8.1%	584,063
Horseback riding on trails	7.9%	569,578
Small game hunting	7.8%	561,735

Source: 2000-2004 National Survey on Recreation and the Environment. USDA Forest Service. Southern Research Station. Athens, Georgia. *George Washington NF market area: 131 counties, 16 and older population (2010 Census estimate).

The Resources Planning Act (RPA) Assessment reports on the status and trends of the Nation's renewable resources on all forest and rangelands, as required by the Forest and Rangeland Renewable Resources Planning Act of 1974. The RPA mandates periodic assessments of the condition and trends of the Nation's renewable resources including recreation, fish, wildlife, biodiversity, forest and range resources as well as land use change, climate change and urban forestry. Consistent with this Act, the U.S. Forest Service Southern Research Station and the University of Georgia, Athens, develop and present outdoor recreation participation projections for specific recreation activities or recreation composites for regions of the United States. Future renewable resource conditions are influenced by changes in population, economic growth, and land uses. Using these major drivers, three equally likely scenarios were used by the 4th Assessment by the Intergovernmental Panel on Climate Change (IPCC 2007) and are adopted by the U.S. Forest Service and University of Georgia in developing projections for participation in outdoor recreation.

Table 3C1-4 provides national projections in public participation in outdoor recreation activities. This list of individual activities or activity composites was derived from the National Survey on Recreation and the Environment. An individual is said to have participated in an outdoor recreation activity if he reported engaging in that activity at least once in the preceding 12 months.

Table 3C1-4. Fifty Year Projected Activities in Outdoor Recreation, thousands

Recreation Activity	2010	2020	2030	2040	2050	2060
Camping						
Developed Camping	105.16	117.44	130.13	140.87	151.81	163.68
Resorts, Cabins	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL FOR GROUP	105.16	117.44	130.13	140.87	151.81	163.68
Driving						
Driving For Pleasure	47.77	53.38	59.19	64.06	68.98	74.36
Other Motorized Travel	0.83	0.93	1.03	1.12	1.20	1.30
Motorized Water Travel	24.42	27.23	29.74	32.29	35.36	38.78
TOTAL FOR GROUP	73.02	81.55	89.96	97.47	105.54	114.45
Fishing						
Fishing	189.82	208.12	224.94	238.62	253.22	268.93
General						
General Relaxing	74.05	82.75	91.75	99.30	106.93	115.28
Swimming	57.19	64.51	71.78	78.49	85.70	93.63
TOTAL FOR GROUP	131.24	147.27	163.53	177.79	192.63	208.91
Hiking						
Hiking/Walking	210.56	237.34	265.76	291.31	318.09	347.74
Hunting						
Hunting	99.49	104.57	108.09	110.14	112.29	114.34
Nature						
Visiting Historical Sites	0.00	0.00	0.00	0.00	0.00	0.00
Visiting Nature Centers, VIS	1.23	1.38	1.54	1.69	1.83	1.99
Gathering Berries, Natural Products	10.92	12.31	13.74	15.00	16.31	17.75
Nature Study	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL FOR GROUP	12.15	13.69	15.28	16.68	18.14	19.74

Recreation Activity	2010	2020	2030	2040	2050	2060
Off-Highway Vehicles						
Off-Highway Vehicles	8.34	9.03	9.56	10.15	10.88	11.65
Primitive Camping						
Primitive Camping	5.01	5.52	6.00	6.44	6.91	7.42
Backpacking, Camp in Unroaded Areas	3.34	3.68	4.00	4.29	4.61	4.95
TOTAL FOR GROUP	8.35	9.20	10.01	10.73	11.52	12.36
Picnicking						
Picnicking	7.36	8.22	9.11	9.86	10.63	11.46
Trails						
Bicycling	15.13	17.05	18.88	20.79	22.99	25.46
Horseback Riding	2.52	2.82	3.08	3.37	3.73	4.13
Non-Motorized Water Travel	1.67	1.82	1.93	2.07	2.24	2.42
TOTAL FOR GROUP	19.32	21.69	23.90	26.23	28.96	32.02
Viewing						
Viewing Scenery	117.33	131.12	145.38	157.35	169.43	182.66
Viewing Wildlife, Birds, Fish	72.95	82.47	92.70	100.67	108.36	116.76
TOTAL FOR GROUP	190.28	213.60	238.08	258.02	277.80	299.42
Wilderness						
Wilderness	11.48	12.64	13.75	14.75	15.83	16.99
TOTAL FOR ALL GROUPS	1,066.56	1,184.35	1,302.08	1,402.63	1,507.33	1,621.68

Data Source: Bowker, J. M. and Askew, Ashley (2012) Outdoor Recreation Participation Projections to 2060. GTR-SRS-150. Asheville, North Carolina: U.S. Department of Agriculture, Southern Research Station. The data for three projections scenarios were averaged by Paul Arndt, Regional Planner, U.S. Forest Service Southern Region. Omitted from the list are various winter sports, which are not relevant to projections for the Southern Region.

The activities with the most projected per capita participation by year 2060, nationally, are hiking/walking, fishing, viewing scenery, developed camping, viewing wildlife and general relaxing. The activities with the greatest percent of growth in participation from 2010 to 2060 are bicycling, hiking/walking, horseback riding, swimming, visiting nature centers, gathering forest products such as berries, viewing wildlife and motorized water sports.

Demographic information collected for the 2001 Recreation Realignment report within the market area revealed trends that were popular across a variety of demographic groups (age, gender, number of people per household, race and ethnic strata). At the time of the Recreation Realignment effort, these were primarily those that do not require specialized skills or equipment and that can engage multi-generations together. The ten most popular activities on the George Washington National Forest, according to the Recreation Realignment Report, were viewing/photographing wildlife and birds, viewing/photographing features and scenery, swimming, hiking or walking for pleasure, visiting a Wilderness, gathering forest products, fishing, camping in a developed site, and ATV/OHV use.

Recreation Supply

For planning purposes, recreation supply is defined as the opportunity to participate in a desired recreation activity in a preferred setting to realize desired and expected experiences. Recreationists choose a setting and activity to create a desired experience. The US Forest Service manages a supply of settings and the facilities to accommodate recreational pursuits appropriate to those settings in a manner that protects the resources.

Settings Supply

The Recreation Opportunity Spectrum (ROS) is a planning tool used to identify and evaluate the supply of recreation settings on national forests. Four ROS classes were inventoried on the George Washington National Forest. These settings include Semi-Primitive Non-Motorized (SPNM), Semi-Primitive Motorized (SPM), Roaded Natural (RN), and Rural (R).

Primitive (P) is the most remote, undeveloped recreation setting. These settings are generally unmodified, natural environments located at least three miles from any open road and are 5,000 acres in size or larger. Interaction between users is very low and motorized use within this area is not permitted. The area is managed so that it is essentially free of evidence of on-site controls and restrictions. There were no areas on the George Washington National Forest that met the inventory criteria for Primitive.

Semi-Primitive Non-Motorized (SPNM) areas are predominated by a natural or natural appearing environment. Interaction between visitors is low, but there may be evidence of other users. They are managed to achieve a sense of remoteness, although SPNM areas can be as small as 2,500 acres in size and only a half-mile or greater from any open road. These areas are managed to minimize the presence of on-site controls and restrictions. These settings accommodate dispersed, non-motorized recreation.

Semi-Primitive Motorized (SPM) areas are natural or natural appearing. Interaction between visitors is low, but there often is evidence of other users. Motorized use is permitted. SPM accounts for areas on the National Forest that either buffer SPNM areas or stand alone as tracts of land 1,500 acres or larger with a low road density of 1.5 miles of road per 1,000 acres.

Roaded Natural (RN) settings are natural appearing with moderate evidence of sights and sounds of humans. Interaction between visitors may be low to moderate, but evidence of other users is prevalent. Conventional motorized access is accommodated. RN areas are located within a half mile of a road and usually provide higher levels of development such as campgrounds, picnic areas and river access points.

Rural (R) settings are substantially modified natural environments. Sights and sounds of other humans are readily evident and interaction between users may be moderate to high. Facilities for concentrated motorized use and parking are provided. Rural settings represent the most highly modified natural settings on the forest and include only highly developed recreation sites. They are so small that they are represented with a point, rather than a polygon, in our Geographic Information System. Acreage in the Rural ROS class is negligible.

Table 3C1-5 shows the current inventoried supply of these four ROS settings on the GWNF.

Table 3C1-5. Current Distributions of ROS Classes as Inventoried on the George Washington National Forest

Recreation Opportunity Spectrum (ROS) Class	Current ROS Inventory Acres on the GWNF (approximate acres)	Current Percentage of each ROS Class on the GWNF
Semi-Primitive Non-Motorized - SPNM	198,281	18.6%
Semi-Primitive Motorized - SPM	210,992	19.8%
Roaded Natural - RN	656,596	61.6%
Total	1,065,872	100%

There are no lands on the GWNF that meet the inventory requirements for Primitive ROS setting (due to proximity to roads). However, the GWNF manages all designated Wilderness (42,674 acres) as Primitive ROS setting. Only highly developed campground complexes meet the characteristic of Rural ROS.

The Southern Appalachian Assessment: Social, Cultural, Economic Technical Report (SAMAB 1996d) provides data about landscape settings in 10 ecological sections of the Southern Appalachians. The report includes settings on both public and private lands. It states that about 5% of the region is developed into urban settings and 12% is developed into suburban or transitional settings. Approximately 45% of the landscape is in rural settings, 2% are covered in large rivers and lakes and 3% could not be determined using satellite imagery. About 8% of the area in the study provides Primitive or Semi-Primitive settings, with 100% of the Primitive settings being provided on public lands. This reveals that the GWNF's supply of semi-primitive settings, at about 38% of the forest, is significantly high compared to the 8% total offered in the Southern Appalachians. The GWNF is uniquely able to offer a recreation setting that is in relatively low supply in this part of the country.

Developed Recreation Facilities Supply

The GWNF manages a variety of facilities located in developed recreation sites. A developed site is characterized by a built environment containing a concentration of facilities and services used to provide recreation opportunities to the public. They typically represent a moderate to significant investment in infrastructure and are managed under the direction of an administrative unit in the National Forest System.

Recreation sites are developed within different outdoor settings to facilitate a variety of desired recreational uses. Developed recreation sites include campgrounds, picnic areas, shooting ranges, swimming beaches, interpretive sites, visitor centers and historic sites. Developed recreation sites provide different levels of user comfort and convenience. The development scale for recreation sites range from 1 to 5, with the lower end of the scale representing the most primitive, natural settings. Site amenities are provided only if needed for the protection of resources. The upper end of the scale represents the highest level of development with facilities provided for the comfort and enjoyment of the visitor.

The George Washington National Forest has three development scale 5 recreation areas: Bolar Mountain, Sherando Lake and Trout Pond. Each is a recreation complex offering amenities and services for the comfort of users. They offer multiple types of camping facilities (family and group) and campsites with utility hookups. The campground roads and walkways are paved, bathhouses have flush toilets and warm water showers, campsites are numbered and delineated, and each complex offers a highly developed day use area. There is an entrance station and on-site staff and volunteers. A percentage of the campsites are available by reservation.

Brandywine Lake, Cave Mountain Lake and Morris Hill are three examples of development scale 4 campgrounds. They offer facilities for the comfort of users including bathhouses with flush toilets and showers and have day use areas. However they are smaller in scale than the development scale 5 sites and they do not offer utility hookups. Volunteer campground hosts are on-site during the peak use season.

Hidden Valley and North Creek are examples of development scale 3 campgrounds. This development scale typically offers gravel roads, numbered campsites, restroom facilities that may have vaults rather than flush toilets and no showers. There is typically, but not always, an on-site volunteer campground host during peak season weekends.

Development scale 2 sites include campgrounds like Greenwood Point, McClintic Point and North River. These provide facilities for the protection of resources rather than for visitor comfort. These are smaller areas offering vault toilet buildings, gravel roads (except Greenwood Point that is accessed only by boat or hiking trail), campsites typically are not numbered or delineated, and rarely, if ever, is there an on-site volunteer host. Some do not offer drinking water or trash collection – users pack in drinking water and pack out trash. Mowing is done infrequently or not at all.

The Forest Service defines the capacity of developed recreation sites in terms of "people at one time" that a site can support, called PAOTs. Currently, there are 59 developed sites managed by the George Washington

National Forest to accommodate different recreation activities. Tables 3C1-6 and 3C1-7 illustrate the different types of facilities provided across the forest and their current capacity in PAOTs.

Table 3C1-6. Current Supply of Day-Use Developed Areas on George Washington NF

Site Type	Number of Sites	Total Capacity (PAOTs)
Motorized Boating Sites*	2	350
Campgrounds & Complexes**	21	6,740
Horse Campgrounds	1	25
Interpretive Sites	10	815
Observation Sites	4	485
Picnic Sites	10	730
Swimming Sites*	7	945
Target Ranges	4	120
Grand Total	59	10,210

Source: INFRA-Recreation Sites Report. INFRA is a Forest Service database that contains all developed recreation sites inventory data.

*Coles Point offers both a swimming area and a boat ramp. The entire capacity of Coles Point is listed with the swimming site.

** All of the level 5 campgrounds and three of the level 4 campgrounds have day use lakes with sand swimming beaches. The capacity of these day use areas is included with the Campgrounds & Complexes.

Several development scale 2 campgrounds on the George Washington National Forest developed over time in response to riparian resource degradation and sanitation concerns in concentrated use areas along popular river and stream corridors. Facilities installed to protect resources have included vault toilets, designated parking areas and hardened impact areas for camping. A couple of examples where developed facilities are provided to protect resources from the impacts of what were originally dispersed recreational uses are Oronoco and North River campgrounds. The supply of the lower development scale facilities provided by the George Washington National Forest currently exceeds demand. Occupancy is typically low at the majority of the development scale 2 and low 3 recreation sites, with seasonal variability. For most of the lower development scale sites, occupancy increases during spring and fall hunting seasons, but rarely to full capacity at most campgrounds.

At the upper end of the development scale, the public demand for campsites is greater than the demand for lower development scale sites. However, demand rarely exceeds supply, except during the summer holiday weekends. The exception to this is Sherando Lake family campground, which routinely fills to capacity throughout the summer. Across the George Washington National Forest, demand for campsites with utility hookups typically exceeds supply. The Forest has not installed additional utility hookups in recent years due to the cost of installation and ongoing maintenance, desires to reduce rather than increase our carbon footprint, and in keeping with our Forest's recreation niche which is primarily trails and dispersed recreation. State parks and private sector campgrounds are typically more highly developed than Forest Service campgrounds and are more capable of meeting public demand for campsites with hookups and other amenities.

Dispersed Recreation Facilities Supply

Developed Sites That Support Dispersed Recreation Uses: Dispersed recreation is defined as those activities that occur outside of developed recreation sites such as boating, hunting, fishing, hiking and biking. The developed sites that help accommodate dispersed recreationists typically provide parking and an information board, and some also provide vault toilets. Very few provide picnic tables and/or benches. Boating areas

provide a boat ramp. Also included as developed recreation facilities that support dispersed recreation activities are overnight trail shelters on long distance trails.

There are 56 developed recreation sites that support dispersed use of the forest. Table 3C1-7 provides a summary of these sites used to access or accommodate dispersed recreation opportunities on the national forest.

Table 3C1-7. Developed Access Points for Dispersed Recreation on the George Washington NF

Site Type	Number of Sites	Total Capacity (PAOTs)
River and Lake Boating Access	9	325
Fishing Sites	7	701
Observation Sites	3	96
Hang Gliding Sites	4	70
Trail Shelters	13	109
Trailheads	20	1,307
Grand Total	56	2,608

Source: INFRA-Recreation Sites Report, 08/20/2010. INFRA is a Forest Service database that contains all developed recreation sites inventory data.

Trails: The George Washington National Forest offers approximately 1,078 miles of trails. The majority are for non-motorized, multiple uses and are shared by hikers, equestrians and bicyclists. Notable exceptions are the Appalachian National Scenic Trail and several short interpretive trails that are open to hikers only and trails in designated Wilderness where bicycles are prohibited. Also excluded from multiple uses are some trails within developed recreation areas. Approximately 65 miles on three trail systems provide motorized use opportunities. All three trails are open to all-terrain vehicles and motorbikes, and one of the three trails has portions open to off-road or four-wheel drive trucks.

Table 3C1-8 gives a breakdown of the miles of trail that are managed for various types of uses. The total trail miles do not equal the total National Forest System Trail miles because of the overlap in uses allowed.

Table 3C1-8. Approximate Miles of Trail Offered on the George Washington NF

Type of Trail	Miles	Comment
Wilderness	68	
Non-Wilderness	1,010	
Trail miles that allow hikers	1,078	
Trail miles that allow equestrians	811	All except Appalachian Trail, interpretive trails, and trails within developed recreation areas including angler trails
Trail miles that allow bicyclists	794	All except Appalachian Trail, trails in designated Wilderness, interpretive trails and certain trails within developed recreation areas including angler trails
Trail miles that allow ATVs and motorbikes	65	Allowed on designated motorized trails only

Source: INFRA-Trails Report, 08/30/2010

Demand for long-distance trails for special recreation events, such as long-distance mountain bicycling, equestrian endurance rides and runner marathons, has increased in recent years. The demand is greatest among the equestrian and mountain biking communities. Events are not permitted in designated Wilderness or on the Appalachian National Scenic Trail. Concern has been expressed among some in these user groups that

any additional Wilderness designations exclude, to the extent possible, trails that currently are used, or that by their connectivity to other trails could be used, for long-distance trail riding opportunities and special recreation events.

There is more demand than supply for motorized trail opportunities. There was a goal in the 1993 George Washington National Forest Land and Resources Management Plan to add a new motorized trail in the area of Archer Run. However, the Archer Run area does not meet the environmental criteria for establishing a new ATV trail. Furthermore, due to concerns with resource damage on and off trail, the Patterson Mountain all-terrain vehicle trail on the north end of the Jefferson National Forest is temporarily closed and potentially could be closed permanently, putting more stress on the motorized trails of the George Washington National Forest. Public concern was expressed during at least one public meeting about losing local economic benefits of motorized trail users who travel to West Virginia to find an adequate supply of this type of recreation opportunity.

The ability of the national forest to provide such a significant trails program is largely dependent on the volunteer workforce that helps with maintenance of trails. In fiscal year 2011, volunteers contributed approximately 43,320 hours to the dispersed recreation program, equivalent to 21 full time employees. The motorized trail program relies heavily on grants from the Virginia Recreational Trails Fund program. While support from volunteers and the grant programs have each been consistent, a decline in either of these programs will have negative implications for the sustainability of the trail program.

Hunting and fishing are traditional and popular dispersed recreational uses of the George Washington National Forest. The Forest Service manages the habitats that sustain populations of small and big game species as well as cold and warm water fisheries. The Virginia Department of Game and Inland Fisheries and the West Virginia Division of Natural Resources stock certain streams and lakes. Table 3C1-9 provides acres currently managed for fish and wildlife habitat emphasis.

Table 3C1-9. Acres of Current Fish and Wildlife Habitat Emphasis Areas

Type of Fish & Wildlife Habitat Emphasis	Unit of Measure
General Big & Small Game Habitat	315,801 Acres
Early Successional Habitats	33,442 Acres
Stocked (Put & Take) Streams	67 Miles of Streams
Stocked (Put & Take) Reservoirs	2,830 Acres

Sources: Data for game and early successional habitats – spreadsheet titled "ROS_Acres_AltsComparison_10.21.2010.xlsx" provided by GIS Specialist; this table include acres for prescription areas 8 and 13 only, which emphasize wildlife habitat management. Data for stocked streams and reservoirs was obtained from the Virginia Department of Game and Inland Fisheries website at http://www.dgif.virginia.gov/fishing/stocking/ and West Virginia Division of Natural Resources at http://www.wvdnr.gov/Fishing/Regs10/TroutStocking.pdf.

DIRECT, INDIRECT EFFECTS AND CUMULATIVE EFFECTS

As the population increases, recreation demand is expected to grow for a variety of activities including dispersed and developed recreation. New, unforeseen uses will also likely arise as technology and entrepreneurs develop new outdoor equipment and as changes in population demographics and/or income levels shift user preferences.

General themes were developed for each alternative that emphasize different resource management objectives. Alternative A is the current management alternative and it provides the baseline for evaluating other alternatives. Each alternative theme and its allocation of prescription areas provide the parameters for redefining the current distribution of the Recreation Opportunity Spectrum (ROS) which has implications for both developed and dispersed recreation settings, facilities development and potentially for road management. The suitability of road construction was a factor in determining the effects of each alternative to recreation.

National Forest management could affect recreation by constructing or removing recreation facilities and improvements, changing their development level, restricting, prohibiting or encouraging use, altering the land to make it suitable or unsuitable for use, and changing the landscape setting. There is such a wide range of user preferences, that any given management emphasis will typically result in some users being satisfied and others being dissatisfied. For example, those that enjoy motorized access to reach early successional habitat for hunting will likely not be pleased with an alternative that emphasizes decommissioning roads and late successional habitat. However, those that prefer hiking into remote settings with mature forests will likely be satisfied.

Refer to other sections of the FEIS for additional environmental consequences related to Scenery, Wild & Scenic Rivers, Wilderness, Potential Wilderness Areas, and Special Areas and Cultural resources.

Settings - Recreation Opportunity Spectrum (ROS)

Table 3C1-10 provides a comparison by alternative of the percent of acres in the current ROS inventory that could potentially change because they are allocated to prescription areas with an emphasis that may be inconsistent with the inventoried setting. Specifically, prescription areas where construction of permanent roads is allowed could be inconsistent with semi-primitive non-motorized (SPNM) and semi-primitive motorized (SPM) ROS settings. The construction of low level temporary roads is consistent with SPM and SPNM. Allocations to the Recommended Wilderness prescription area might result in the closing of roads, which is not consistent with the Roaded Natural ROS setting.

Under the current management plan that has been in place since 1993, about 123,000 acres of inventoried SPM and SPNM (about 30% of total semi-primitive acres) are in management areas that allow road building. About 188,000 acres of inventoried RN areas (also about 30% of total RN acres) have been allocated to areas managed to provide settings that lean to the semi-primitive end of the spectrum. While it is important to analyze the potential consequences of allocating lands to prescriptions that may be inconsistent with their inventoried ROS status, it should also be noted that the allocations of areas to management prescriptions that allow or prohibit road building have not resulted in a significant change in the ROS inventory since 1993.

Table 3C1-10. Percent of Acres in Prescription Areas with Emphasis That May Not Be Consistent With Current Inventoried ROS Classification

ROS Class	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
SPNM* 198,281 acres	10-15%	15-20%	<1%	15-20%	10-15%	5-10%	10-15%	10-15%
SPM* 210,995 acres	45-50%	60-65%	5-10%	40-45%	45-50%	45-50%	50-55%	50-55%
RN** 656,596 acres	25-30%	35-30%	55-60%	25-30%	30-35%	25-30%	30-35%	25-30%

*The first two rows for SPNM and SPM indicate the potential percent of acres that could move toward the RN end of the spectrum. The SP inventory status will not change unless new roads are constructed of the development level and distance to the current ROS boundary that would result in an inventory change, whether the road is inside or outside of the national forest.
**The last row, for RN, indicates the percent of inventoried RN acres that would be allocated to prescriptions that are managed more consistently with semi-primitive settings. The RN inventory status will not change unless roads are permanently closed that would result in a change to that RN inventory.

The alternative that could bring about the least change to the SPNM and SPM inventoried acres is Alternative C. Alternative F also fundamentally provides for the protection of SPNM recreation settings. The alternatives in the middle of the range for protecting SPNM are Alternatives A, E, G, H and I. The alternatives that could result in the most potential change to the SPNM inventory are B and D.

Areas of SPM occur in multiple prescription areas that would allow the construction of permanent roads, including utility corridors, ATV use areas, dispersed recreation, range, Wild and Scenic Rivers (recreation classification), mix of successional habitats (suitable and unsuitable), early successional habitat (suitable and unsuitable), timber production, mosaics of wildlife (suitable and unsuitable), source water watersheds, and Indiana bat-secondary conservation areas. Alternative B provides the potential for the greatest number of inventoried SPM acres to change. This is followed by Alternatives G, H and I and then Alternatives E and F, then finally D. Alternatives G, H and I have an objective to maintain 85% of the inventoried SPM areas in their SPM settings. Those alternatives also include a strategy to close newly constructed roads in SPM areas as soon as the immediate access need is met. With this objective and strategy the actual amount of existing SPM areas that may not be consistent with the current inventory should be near zero. Alternative C substantially protects the SPM recreation settings.

The alternatives that provide for management of the RN areas most consistently with the RN end of the spectrum are A, D, F, H and I, followed by E, G and then B with percent of area that would be managed more toward the SP end of the spectrum. Alternative C manages the highest percent of RN acres consistently with the SP end of the spectrum.

Under Alternative C, and to a lesser extent Alternative F, effects of changes in ROS settings will be positive for those visitors seeking a more remote experience, and less positive or potentially negative for those visitors who prefer a more developed experience. Under Alternatives B and D, the effects of change in settings will be positive for those visitors seeking increased access and a more developed recreation setting, and less positive or potentially negative for those visitors who prefer a more remote experience. In Alternatives A, E, G, H and I, the changes in the recreation settings will result in fewer effects but changes will favor increasing RN and decreasing SP.

Increasing remote settings may be associated with road closures in some areas, both seasonal and permanent. Closing roads increases the satisfaction of visitors that prefer solitude and fewer disturbances by motorized vehicles. Road closure often reduces wildlife poaching, litter and the development of unauthorized trails.

Increasing developed settings may be associated with construction of new permanent roads whether they are constructed primarily for management or recreational purposes. Increased motorized access to more areas of the national forest increases the satisfaction of visitors who hunt, fish, photograph scenery, birdwatch, pick berries, and disperse camp. The roads themselves are often enjoyed by people with limited mobility and/or limited time to recreate on the national forest.

Developed Recreation

The developed recreation capacity in 1993 was 13,820 persons at one time (PAOTs). The 1993 Forest Plan provided for the expansion of 10 campgrounds, 1 picnic area, 1 fishing/picnic area and an organizational camp. It also provided for the development of new recreation areas including 5 minimally developed campgrounds, 1 horse campground, 2 interpretive sites and 3 target ranges. The total projected capacity to be achieved was 16,200 PAOTs. During Plan implementation, there were expansions at several recreation areas, one minimally developed campground was constructed, the horse campground was developed, and one new target range was constructed. However, due to budget constraints, most of the expansions and new facilities were never developed. The organizational camp planned for expansion was closed along with 2 visitor centers, 3 minimally developed campgrounds, 2 specialized sites (hang gliding), 2 picnic areas and a trailhead. One organizational camp was converted to an administrative site. PAOTs have been reduced since the 1993 Plan, and the method by which PAOTs are counted has changed as well. Current developed recreation capacity is estimated to be 10,225 PAOTs plus 2,608 PAOTs that support dispersed recreation opportunities for a total of 12,833.

Assuming for Alternative A that the expansions and planned new facilities listed in the 1993 Forest Plan will still occur, but the closed and disposed sites will not be reopened, and using current PAOTs for existing sites, the projected capacity is 12,546 PAOTs. The developed recreation facilities that support dispersed activities

(trailheads and trail shelters) would supply another 1,188 PAOTs. Table 3C1-11 below indicates the range of developed recreation capacity by alternative excluding developed sites that support dispersed recreation, with the baseline being current capacity.

Table 3C1-11. Estimated Capacity (PAOTs) of Developed Recreation Areas by Alternative

Site Type	Alt A[1] Current Capacity (Baseline)	Alt A No Action	Alt B Increase 0 - 5%	Alt C Decrease 5-15%	Alt D No change	Alt E Decrease 5-15%	Alt F Increase 5 - 15%	Alts G, H and I Increase 0 - 5%
Water Based Recreation: Swimming, boating, developed fishing	1,295	1,315	1,295-1,360	1,101-1,230	1,295	1,101-1,230	1,360-1,489	1,295-1,360
Overnight Use: Family, Equestrian, Group Campgrounds	6,765	7,996	6,765-7,103	5,750-6,427	6,765	5,750-6,427	7,103-7,780	6,765-7,103
Interpretive and Observation Day Use Sites	1,300	2,220	1,300-1,365	1,105-1,235	1,300	1,105-1,235	1,365-1,495	1,300-1,365
Day Use Picnic Sites	730	870	730-767	621-694	730	621-694	767-840	730-767
Specialized Sports Sites*	135	145	135-142	115-128	135	115-128	142-155	135-142
Grand Total	10,225	12,546	10,225-10,736	8,691-9,714	10,225	8,691-9,714	10,736-11,759	10,225-10,736

Alt A[1] represents the actual implementation level of the 1993 Revised GWNF Plan
* Specialized sports sites include target ranges and hang gliding sites.

In all alternatives there will be an emphasis to upgrade the accessibility of existing and expanded sites, which are considered high priority improvements. Effects include a greater satisfaction for users of all abilities as more sites become accessible. Families of all ages and ability levels can share the same facilities and site furnishings, and visitors will find their choices have broadened in selecting campsites, picnic sites, shooting range lanes, and other types of developed recreation sites.

None of the alternatives meet the demand for developed recreation opportunities that serve activities such as highly developed camping and swimming, or developed fishing sites which are typically at the lower end of the development scale. The effects of this unmet demand will be greatest with Alternatives C and E, followed by D. Alternatives B, G, H and I are in the middle of the range of alternatives. Alternatives A and F meet more of the demand than the others, with A best meeting this demand. The ability to meet demand for developed recreation will diminish with time as the population increases while the amount of public lands offering these opportunities remain static.

Some sites will become increasingly overused and crowded, particularly the highly developed campgrounds and day use areas. Initially this may occur only at peak times such as holidays and weekends; but over time this could extend to the entire primary recreation season from Memorial Day to Labor Day. This will result in lower satisfaction levels as people are turned away from full recreation areas, and some visitors will have unmet expectations. Some will seek the supply of developed recreation provided on state, county and private lands.

Hotspots of developed recreation are sites that are consistently at or over their design capacity. On the George Washington National Forest these include areas such as Sherando Lake throughout most of the summer as well as Bolar Mountain and Trout Pond Recreation Areas on most weekends and holidays. Hotspots of use for developed recreation will broaden over time to other recreation areas and into the shoulder use seasons.

Putting sites on the national reservation service and implementing visitor use controls may help alleviate problems of overuse at these sites.

Some management actions will effect developed recreation, and effects will depend on the proximity and magnitude of the activity. These activities include construction, reconstruction and maintenance of roads and trails, insect and disease control, prescribed burning and pesticide use. Some activities have short-term effects such as prescribed burning or pesticide use that decrease the satisfaction of the visitors in the area for a short time. Other activities such as road construction or major repairs to facilities may influence satisfaction on a longer basis, perhaps up to a year.

The degree to which new roads are constructed could be a factor for Alternative A which includes the development of new recreation sites. Roads are needed to access developed recreation areas. The degree to which new roads are constructed is not a significant factor for any of the action alternatives because they propose no new developed recreation areas, only the expansion or reduction of existing sites. The degree to which roads might be closed could potentially be a factor if it would result in closing vehicular access to an existing developed recreation area. Alternative C provides for the most potential miles of road decommissioning. Alternatives A and D provide for the least miles of road to be decommissioned.

Natural disturbances, such as wildfires, can greatly affect developed recreation areas long-term or permanently. The use of prescribed burning in the vicinity of developed recreation areas results in the reduction of fuels for wildfires. Alternative E provides the largest prescribed burning program, while Alternative C provides for the least.

Dispersed Recreation

Trails: The George Washington National Forest currently has over one thousand miles of trails. Agency trail managers have struggled to meet targets related to maintaining existing trails to standard and question the ability of the national forest to continue to sustain the current level of trail miles. However, user groups that enjoy both non-motorized and motorized trails, including active volunteer organizations that help accomplish trail maintenance, would like to see the trail miles on the national forest increased.

Non-Motorized Trails: With the exception of the Appalachian National Scenic Trail, trails in Wilderness and some paved interpretive trails, this national forest allows and encourages multiple uses of its non-motorized trails. The biggest changes between the alternatives is the miles of trail currently open to mountain bicycles that would be closed to that use if Recommended Wilderness Study areas are designated by Congress as Wilderness. The second influential factor in trail miles is the provision in some alternatives that an increase in trail miles can occur but with no net increase in the amount of trail maintenance that would be required. This would be accomplished through relocating or decommissioning unsustainable trails, adding new trails or trail connectors in appropriate locations, and constructing trails using design standards that result in minimal maintenance needs and maximum sustainability. The following table indicates the estimated changes from current miles that might occur in each Alternative.

Table 3C1-12. Estimated Changes in Non-Motorized Trail Miles Open to Various User Types

Type of Trail	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Hiking, Pack-and-Saddle, Mountain Bicycling	Increase 0-3% <30 miles	No net change	Increase <3% <30 miles	Increase 5-10% 50-100 miles	No net change	Increase <3% <30 miles	Increase <3% <30 miles
Effect of Wilderness Designation on Mountain Bicycling on Designated System Trails*	No change	Loss of 9 miles of trail	Loss of 434 miles of trail	Loss of 1 mile of trail	Loss of 11 miles of trail	Loss of 70 miles of trail	Loss of 9 miles of trail

* The allocation of land to Recommended Wilderness will not affect mountain bike use in those areas. However, if Recommended Wilderness Areas are designated as Wilderness by Congress, then all mechanical and motorized transport forms of recreation, such as mountain bicycling, will be prohibited according to the Wilderness Act of 1964.

Motorized Trails and Roads for OHV Use: Mixed comments were received regarding the level of motorized trail opportunities that should be provided. Some comments suggested eliminating or decreasing opportunities for off-highway (OHV) and all-terrain vehicles (ATV). Most of the comments related to motorized recreation referenced high-clearance 4x4 trails and roads for OHV use. Some people desiring this type of opportunity requested that OHV routes be specifically identified and managed for that use.

Some comments received requested that the current level of ATV trails provided be maintained or increased. The site requirements for constructing new motorized trails are difficult to meet. The proposed Archer Run ATV Trail in the 1993 Forest Plan did not meet site requirements. The following table indicates the estimated changes from current miles of motorized trails and featured OHV routes that could occur by alternative.

Table 3C1-13. Estimated Change from Existing Miles of Motorized Trails by Alternative

Type(s) of Motorized Use Allowed	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
ATVs* and motorcycles	Increase 10-25%, or 6-16 miles	No change	No change	Increase 25-60%, or 16-40 miles	No change	Increase up to 10%, or 6 miles	Increase 5-10%, or 3-6 miles
OHVs**	Increase 0-25 miles; roads are featured for OHVs.	No featured OHV roads; current level of high clearance roads	No roads managed for OHVs	Increase 20-40 miles; roads are featured for OHVs	No roads manage d for OHVs	No featured OHV roads; current level of high clearance roads	No featured OHV roads; current level of high clearance roads

*ATV = Unlicensed four-wheeled vehicle, 50" wide or less, controlled by handle bar (not steering wheel), and has a seat that is straddled.
**OHV = Street legal, 4-wheel drive, high clearance vehicle.

Increases in ATV/OHV trail riding opportunities will increase noise disturbance and may lessen the experience of other recreation participants such as hikers, hunters, fishermen, campers, and those seeking solitude.

Alternative A increases trail construction of both motorized and non-motorized trails and identifies featured OHV roads. Under Alternatives A and D, the improved and expanded trail systems will reduce some of the unauthorized off-trail use.

Alternatives B and E include no significant increase or decrease in the current motorized or non-motorized miles of trail. Specific OHV roads are not featured in Alternative B, but high clearance roads will continue to be provided for OHV use at the current level. Under Alternative E, no roads are managed for OHVs. Other than this distinction in the OHV program, both alternatives have an emphasis on maintaining the current dispersed recreation trails program.

Alternative C has the greatest potential for decreased miles of trail available to mountain bicycling users in the future. Mountain bikes will continue to be allowed in Recommended Wilderness Study areas, but are prohibited by law when Congress designates an area as Wilderness. Alternative C provides for increased miles of non-motorized trail, as long as there is no increase in trail maintenance costs. Alternative C makes maintenance of the trail system more challenging, as hand tools must be used rather than power tools in areas designated as Wilderness. Alternative C would reduce opportunities for recreation special events on the Forest if Recommended Wilderness Study areas are designated by Congress as Wilderness. This would include several annual recreation events such as long-distance pack and saddle enduros and running marathons. Alternative C includes no management for OHV roads, but does allow that existing ATV/OHV trails remain open.

The alternative with the most emphasis on expanding the existing overall trails program is Alternative D. It provides the greatest increases in the dispersed recreation trail systems, including hiking, mountain biking, horseback riding, ATV, OHV and interpretive trails. Alternative D increases dispersed recreation access points such as boat ramps and trailheads the greatest. This will result in greater user satisfaction, increased use of trails and easier access to different parts of the forest for some users. Alternative D also provides for increased interpretive trails that will enhance experiences for most visitors. Also, sharing information with users about

ecosystems, history and resource management through interpretation often results in good partners in management.

However, with improved trails and increased access, some people may experience user conflicts as visitor levels on trails increase. Increases in the trail system could also have effects of more litter, safety concerns, law enforcement needs, search and rescue needs, and increased risk of wildfires. The sustainability of this expanded dispersed recreation program is not addressed in Alternative D.

Alternative F focuses on improving the existing miles of non-motorized trails and improves and expands the existing ATV/OHV trail systems. It promotes a sustainable trails program that allows for expansion only when the resulting level of maintenance will be equivalent to or less than the existing maintenance needs. The improved trail system will increase user satisfaction and sustainability, and will decrease soil movement and sedimentation.

Alternatives G, H and I provide for increased motorized and non-motorized trail miles when it is beneficial for the resources (such as relocations off of steep slopes and wet areas) and the extra miles result in no net increase in maintenance. Alternatives G, H and I do not identify featured OHV routes, but provide for the current level of high clearance roads to be maintained for OHV use.

Scoping comments indicated a need to evaluate the closure of all existing ATV/OHV trail systems. This option was not included in any alternative due to its effects on current uses. If all of the current ATV/OHV trail systems were closed, the following effects could be expected:

- Loss of all legal recreation opportunities for ATV operators
- Loss of revenue to local communities from ATV users
- Increase in illegal use of ATVs on the Forest
- Small decrease in sedimentation in streams draining the existing trail systems
- Reduction in noise in the vicinity of the existing trail systems on the Forest and adjacent private land
- Additional funding available to maintain other trails

All of the alternatives include a prescribed fire program. The preparation and execution of a prescribed burn can temporarily close trails, which may result in short-term dissatisfaction by trail users who need to postpone a recreation trip or find an alternative trail. Trails are sometimes used as control lines during a prescribed burn which can result in physical damage to the trail tread and/or trail profile. Firelines that use trails and then veer off may appear to trail users to be a new trail. Forest Plan standards will require the trails be repaired and any firelines that merge into trail be rehabilitated following a prescribed fire, but the full restoration may require vegetative growth that takes time. The physical impacts to the trail environment can negatively impact the trail user’s experience. Alternative E would have the largest prescribed burning program and therefore has the most potential for causing temporary closures to trails and temporary disturbances to the physical condition of trails. Alternative C, which would have a very limited prescribed burning program, has the least potential for negative impacts to trails.

The construction and presence of roads in close proximity to trails, particularly when they physically cross trails, decreases trail user satisfaction due to noise, dust, safety concerns, and an interrupted trail use experience. Maintenance of the road may also result in damage to the trail at that intersection. Water runoff from the road could damage the trail tread and lead to increased maintenance needs. The alternatives that would have the most impacts on trails are A and D, as they allow for the most miles of new road construction and the least miles of road decommissioning. The alternatives that would have the least impacts, and potential for enhancing trails, are C, D and F because they provide for the least amount of new miles of road construction and the most miles of road decommissioning.

Many trails traverse ridge tops or have a ridge top viewpoint or rock outcrop as a destination. Industrial wind development would negatively impact trails and trail users’ experience if access roads are in close proximity to or cross trails (for the same reasons cited above). The location of wind tower pads and turbines could displace trails and trail destinations on ridge tops. Alternatives C and E would provide the most protection to trails as

they do not allow for any wind development. Pertaining to industrial wind development, Alternative D has the potential for the most impacts to trails, as it makes the entire Forest available for proposals for wind development. Alternative A is silent on direction for wind development.

Hunting and Fishing: According to results from the National Surveys on Recreation and the Environment, the South exceeds the national average for the percent of the population that participates in hunting and fishing. The national forests are the largest provider of hunting and fishing opportunities in Virginia. Table 3C1-14 provides the approximate acreages by alternative for habitats conducive for big and small game hunting.

Table 3C1-14. Estimated Total Acres of Big & Small Game Emphasis Areas by Alternative, thousands

Type of Game Habitat (Management Prescription Area)	Rx Area	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Mix of Successional Habitats	8A1 8A1U	258 70	0 0	0 0	317 0	0 0	0 0	0 0	0 0
Early Successional Habitat	8B 8BU	39 1	0 0	0 0	34 0	0 0	0 0	0 0	0 0
Bear/Remote Habitat	8C 8CU	74 61	0 0	0 0	125 0	0 0	0 0	0 0	0 0
Mosaic of Habitats	13 13U	0 0	569 0	0 246	0 0	491 3	350 109	508 0	508 0
TOTAL ACRES % of GWNF (approx.)		503 47%	569 53%	246 23%	475 45%	494 46%	459 43%	508 48%	508 48%

Alternatives that allocate additional acres to prescriptions that emphasize big and small game habitat will increase and enhance the hunting and wildlife viewing opportunities on the national forest. Detailed wildlife habitat analysis specific to Demand Species is provided in the Final EIS, Chapter 3, in Section B2C.

Alternatives A and D allocate acres to prescription areas specific to the type of habitat being emphasized, including early successional, mixed successional, and bear/remote habitat. Alternatives B, C, E, F, G, H and I allocate acres to a single prescription area with emphasis on providing mosaics of habitats for a variety of terrestrial species, including both game and non-game species.

Alternative B provides the greatest total acres, 53% of the GWNF, with an emphasis on providing wildlife habitat. Alternatives G, H, I, A and E are next with the most acres allocated specifically to wildlife habitat management prescriptions, at 48% to 46% of the GWNF.

Under Alternative D, the number of acres allocated to habitat management for big and small game hunting decreases only slightly from the current Forest Plan (Alternative A), but an emphasis on tourism and increased public access points will result in improved hunting and wildlife viewing opportunities.

Alternative C provides the least acres to prescription areas that emphasize habitat management, and has the potential to provide the least variety of big and small game hunting opportunities. This alternative allocates about 23% of the national forest into the mosaics of habitat prescription area. The emphasis in this alternative is to slowly progress toward late successional forest habitats, relying primarily on natural events such as ice

and wind storms, wildfires, disease/insect outbreaks, and natural tree mortality due to age, to provide early successional habitat often sought by hunters.

Forest users who enjoy hunting species that require early to mid-successional habitats will find their opportunities decreasing as time passes. This results in lower user satisfaction among those hunters. On the other hand, people who prefer hunting for species found in late successional forest habitats will have increased opportunities and increased satisfaction.

Some areas may become easier to access for hunting under Alternatives B, G, H, I and E and some areas may become more difficult to access under Alternative C.

With regards to fishing, a detailed analysis of fisheries and aquatic habitat is found in the Final EIS, Chapter 3, at Section B4A and an aquatic species viability analysis is in Section B4B. The quantity of stocked (put and take) streams and reservoirs are not expected to change over alternatives.

C2 – NATIONAL WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act (Public Law 90-542: 16 USC 1271-1287, October 2, 1968) and its amendments provide for the protection of selected rivers and their immediate environments. To be eligible for designation rivers must possess one or more outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Designation preserves rivers in free-flowing condition, protects water quality and protects their immediate environments for the benefit and enjoyment of present and future generations.

AFFECTED ENVIRONMENT

The 1993 Forest Plan Revision identified 12 streams that were eligible for inclusion in the National Wild and Scenic River System. The 12 eligible rivers or river segments traverse 12 counties in Virginia and West Virginia and have a combined length of 253.55 miles. A summary of the rivers determined to be eligible is Appendix D. Since the 1993 Plan, some additional rivers have been proposed for consideration but were found to not meet the eligibility requirements.

Rivers found eligible need further study to determine if they meet suitability criteria and should be recommended to Congress for addition to the Wild and Scenic River system. Until a final determination is made as to suitability or nonsuitability, the Forest Service is obligated to protect those qualities that made the rivers eligible.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

In all alternatives, protection is provided within a one-quarter mile corridor on each side of an eligible river (one-half mile total) through a land allocation to a management prescription designed to protect the river segment outstandingly remarkable resources. Management activities allowed within this corridor are designed to meet the minimum protection requirements, given the river's potential classification.

C3 – CULTURAL RESOURCES

AFFECTED ENVIRONMENT

The George Washington National Forest contains a multitude of sites representing past human events. Beginning with Native American occupations dating as early as 8000 B.C., the variety of cultural resources is impressive. Prehistoric sites include multi-use base camps, transient camps, hunting and gathering stations, quarries, lithic reduction stations, and rock-shelter occupations. The most common site type is often referred to as a lithic scatter and represents a short-term occupation where stone tools were made and/or sharpened and may be associated with a plethora of ancillary activities.

The earliest sites date to the Archaic Period and span the time from 8000 B.C. to 1000 B.C. Throughout this period, small bands of hunters and gatherers occupied both the mountains and the lower elevations exploiting a wide variety of forest resources. As the Archaic period came to an end, exploitation patterns began to focus on the riverine resources with more sedentary sites found along the rivers. This trend continued through the Woodland Period from about 1000 B.C. to A.D. 1650 where the rich alluvial soils were utilized in an intensification of gardening. The raising of horticulture foods, such as corn, beans, and squash, coupled with increased sedentism, led to an increase in population. Hunting and gathering remained important aspects of the economy and the higher elevations continued to be exploited. Native American sites are found throughout the Forest for all time periods with the exception of the Ice Age Paleo-Indian. Unknown Paleo-Indian sites may exist on the Forest but have yet to be located.

With the advent of the European occupation of the New World, Native American sites decreased in numbers with a concomitant increase in Euro-American sites. The area that is now the George Washington National Forest was first explored by the Europeans in the 17th century and intensive settlement began in the first and second quarters of the 18th century. Welsh, Scotch-Irish, Swedish, and German immigrants traveled down the Great Valley into the area that is now western and southwestern Virginia. The first historic site types were home and farmsteads closely followed by mills. As extractive industries developed through the 19th century, western Virginia and eastern West Virginia became a high producer of iron and timber. Historic sites for this period include log cabins and outbuildings associated with agriculture, cemeteries, mills, schools, iron furnace complexes, mines, colliers pits, logging camps, turnpikes and railroad features. The George Washington National Forest contains a large number of these historic features as well as later sites relating to the Civilian Conservation Corps that attempted to counter some of the environmental damage brought about by over-exploitation.

Standing structures are also important aspects of the historic era and require proactive management. Examples of significant structures on the George Washington National Forest include the Warwick house, Sherando Lake pavilion, Mount Torry Furnace, and Woodstock Tower.

Cultural resources are important resources that require inventory, evaluation, protection, and interpretation. Cultural resource management was previously viewed as a support function for timber management; currently, the trend is toward a resource treatment that recognizes the value of cultural resources in their own right. In order to manage these resources, complete inventories need to be implemented across the Forest. At that point, management alternatives can be developed and National Register of Historic Places nominations completed based on a full regional perspective.

Interpreting cultural resources for the public is an important aspect of cultural resource management. Standing structures readily lend themselves to public education and opportunities exist at the iron furnaces, Confederate Breastworks, and recreation areas originally constructed by the Civilian Conservation Corps. Archaeological sites, because of their fragility, are better interpreted off-site. Forest Service visitor information centers, local museums, historical societies, and traveling exhibits offer opportunities for education. The Forest also needs to recognize its responsibility to address research questions and share information with the lay and professional publics.

DIRECT AND INDIRECT EFFECTS

Direct and indirect effects to historic or cultural resources could result from both natural and human-caused events. These vary depending upon the type of resource, the fragility of the resource, and the type of disturbance, but could include soil disturbance to varying depths, wildfire and prescribed fire, vegetation removal, erection of new structures, looting or vandalism, and land use changes. However, compliance-related inventories or Phase I inventory surveys would be conducted prior to ground disturbance related to project activities.

Accordingly, five types of ground disturbing land management activities that vary in magnitude (acres or miles) have the greatest potential to affect cultural resources. These include: timber management, road construction, fire management, mineral management, and recreation use. To a lesser degree, other forms of land management, such as landownership adjustment (land exchange), special use permits, structures management, and wildlife management can also affect cultural resources.

Timber harvests may directly affect unknown significant cultural resources when soil is significantly disturbed by heavy machinery and vehicles, when trees are felled on historic ruins or cemeteries, when logs are skidded across sites, or indirectly when erosion is caused by removal or disruption of vegetation cover or increased surface soil exposure. In general terms, even-aged harvesting may create moderate to heavy disturbance for significant properties located on the ground surface or at shallow depths, and such disturbance may occur over most of the stand or area being harvested. An uneven-aged harvest or single tree selection would similarly disturb the properties located on the surface and in the upper soil matrix, but disturbed areas would be dispersed within the harvest area.

Table 3C3-1. Estimated Harvest Acres and Allowable Sale Quantity for Timber Management Activities by Alternative, First Decade

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Acres harvest, in thousands, first decade	24	7	30	0	42	18	10	30	30
Allowable Sale Quantity, in million cubic feet, first decade	47	47	55.8	0	105.8	31.1	19.10	55.2	55.3

Alt[1] represents the actual implementation level of the 1993 Forest Plan

Alternative D potentially affects the greatest number of acres through timber harvesting and Alternatives C and F the least. With any timber harvest method, the skid trails, log landings, and other areas where vehicle use is concentrated could receive the greatest depth of disturbance and thus provide the most significant direct effects to significant cultural properties. Indirect effects could include deterioration of sites and artifacts from subsequent erosion and increased site vandalism from increased access and surface exposure of historic sites.

New road construction may directly affect unknown sites, given variables specific to each portion of construction. Disturbance within a construction corridor may remove soil containing cultural deposits, depending on the local situation. In cases where fill is added, cultural resources may be buried deeper. This may protect the site from compaction or rutting, while at the same time essentially precluding additional scientific study using conventional technology. Maintenance or reconstruction of existing roads presents less potential for direct effects to intact archeological sites because the majority of damage to an unknown site probably occurred during the original construction. Access to cultural resources provided by roads, however, may result in indirect effects to significant properties by facilitating increased vandalism. Indirect effects also may include erosion of cultural resources subsequent to road construction. Also, artifact exposure during construction could promote site vandalism.

Table 3C3-2. Average Miles of Road Construction per Year by Alternative

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Road Construction, miles	2.9	1.8	1.5	0	4.1	1	0.5	1.5

Alt[1] represents the actual implementation level of the 1993 Forest Plan

Alternatives A and D potentially has the greatest adverse effects on cultural resources, while Alternatives C and F would have the least adverse effects.

Cultural resources may be directly and indirectly affected by heat damage to artifacts and sites and erosion of sites resulting from wildfires or prescribed fires. High-temperature wildland fire could pose direct effects to cultural resources by damaging surface or shallow archeological sites, standing structures, and cemetery markers. Sites of the historic period are most subject to direct effects from these events because many of these properties are more likely to exhibit surface artifacts. Studies show that wildfire, and in some cases higher temperature prescribed burns, may alter the character and condition of surface artifacts such as melting glass, "crazing" lithic and ceramic artifacts, and burning wood structures.

Prescribed fire could also similarly directly affect surface sites or very shallow site deposits and artifacts, but because of reduced temperature, to a much lesser degree than those fires resulting from wildfire. However, wooden structures and cemetery markers could still be damaged, as could surface artifacts.

Fires lines installed for prescribed burns are less likely to directly or indirectly affect historic resources since proposed fire plow lines in areas of prescribed burns are inventoried and field surveyed for the presence of cultural resources prior to project implementation. Under normal conditions, however, cultural surveys do not precede emergency fireline construction. Thus, there is a potential for unknown properties to be affected by wildfire suppression. Indirect effects following the installation of firelines and burning may include erosion losses due to the removal or burning of vegetation cover or further deterioration of artifact or feature condition following damage by high temperatures.

Table 3C3-3. Acres of Prescribed Fire per Year and Use of Unplanned Ignitions

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Prescribed Fire, acres per year	3,000	7,400	12,000-20,000	Limited	5,000-12,000	20,000	12,000-20,000	12,000-20,000
Unplanned Ignitions	Allow to achieve forest goals	Allowed achieve forest goals	Use to attain ecological objectives for bio-diversity	Allow to burn as much as possible	Use to attain ecological objectives for bio-diversity	Use to attain ecological objectives	Use to attain ecological objectives for bio-diversity	Use to attain ecological objectives for bio-diversity

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Alternative E potentially affects the greatest number of acres through prescribed fire and Alternative C the least. Alternatives B, F, G, H and I follow Alternative E for having the most potential adverse effects on cultural resources.

Recreation management may be categorized as consisting of three types: concentrated developed recreation areas, dispersed recreation areas, and trails (off road vehicle trails, horse trails, and foot trails). In general, direct effects to significant cultural resources can result from installation of recreation facilities and expansion of recreation facilities and recreation use areas. Indirect effects could include soil erosion and compaction of cultural resources due to visitor use, and access to given locales could result in archeological site vandalism. These indirect effects could especially occur with illegal expansions off of established off road vehicle trails.

The incidence of vandalism and illicit collection is very much influenced by visitor use. Greater visitor use to some areas could lead to the increase of vandalism, illicit collection, littering and disturbance to cultural sites under all alternatives. Opening areas to timber production and timber manipulation, recreation use, and roads and trails could result in an increase in site disturbance and vandalism in inaccessible areas that previously were naturally protected from direct, indirect, and cumulative effects. While cultural properties situated in recreation areas and along designated trails and road corridors can be signed, monitored, patrolled and protected, the impacts outside of these areas are largely uncontrolled and the extent of impact unknown. However, the Forest Service does have the authority to close a specific road, trail or area that has considerable adverse effects to cultural resources (36 CFR 295.5, 36 CFR 800.9, and 43 CFR 8342) and prosecute, under 36 CFR 296.4 and other laws, those who willfully destroy or loot significant historic properties.

Table 3C3-4. Percent Change in Developed Recreation Capacity and Dispersed Recreation Trail Miles by Alternative

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Developed Recreation, capacity	No change	Increase 0-5%	Decrease 5-15%	No change	Decrease 5-15%	Increase 5-15%	Increase 0-5%
Trails, miles	Increase 0-3%	No net change	Increase <3%	Increase 5-10%	No net change	Increase <3%	Increase <3%

No new developed recreation areas are planned under any of the alternatives. Increases in capacity will be achieved in Alternatives B, F, G, H and I by expanding existing recreation areas. The majority of this is expected to occur within already disturbed area. The greatest impacts to archaeological resources, related to recreation, could likely come from construction of new miles of trail. Alternative D affects the greatest number of acres through trail construction, and Alternatives B and E the least.

Even though special use permits involve decreased federal jurisdiction of an area, the potential direct effect to significant cultural resources located in special use areas would be low, in most cases. This is partially due to the small acreages involved in special use areas and the limitations imposed upon special uses for the purposes of resource protection. Indirect effects to significant cultural properties located in special use areas, however, can occur through erosion and vandalism of cultural resources resulting from increased access and use of permit areas.

Analysis of effects to significant cultural resources located on lands placed under special use permit is performed programmatically in compliance with existing laws and regulations (36 CFR 296, 800, and the PMOA with the Tennessee SHPO) and occurs on a case-by-case basis apart from alternatives. As such, effects to cultural resources resulting from special use permits are not affected by alternative.

Exploration and development of leasable minerals, oil, gas, and mineral materials could impact cultural resources through access road construction, pipeline construction, well pad placement, and actual removal and displacement of minerals and soil. Mineral extraction may produce severe, albeit localized, direct effects to significant cultural resources as the overburden containing historic resources are removed. Indirect effects could include damage to significant cultural resources located outside the area of immediate mining resulting from erosion, the installation of road accesses and equipment staging areas, and vandalism and looting resulting from increased access to these historic properties.

Analysis of effects of minerals management to significant cultural resources is performed programmatically in compliance with existing laws and regulations (e.g., 36 CFR 296, 800, and the PA with the Virginia SHPO) and occurs on a case-by-case basis separate from alternatives. Therefore, effects to cultural resources resulting from minerals management are not affected by alternative.

Structures located on the George Washington National Forest that are determined to be historically significant are protected and maintained under the terms and conditions of existing federal laws and guidelines. The construction of new facilities could directly affect an unknown significant prehistoric or historic property. In

most cases of concrete slab or footing construction, disturbance may extend into or below soil strata containing archeological deposits. Lighter facilities, such as boardwalks, piers, or structures located on pier foundations, would present less potential for damage although the potential remains.

The construction of new structures, or alteration or removal of historic structures could also directly affect significant cultural resources. An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register, in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Construction of a new structure can introduce a visual effect that conflicts with or diminishes the historic setting and context of a property. Indirect effects could include erosion or vandalism of significant cultural resources facilitated by public access following construction of structures in the immediate vicinity.

Analysis of effects to significant historic structures and the effects of the construction of structures to cultural resources is performed programmatically in compliance with existing laws and regulations (e.g., 36 CFR 296, 800, and the PA with the Virginia SHPO) and occurs apart from alternatives. As such, effects to cultural resources resulting from land exchange from federal jurisdiction are not affected by alternative.

CUMULATIVE EFFECTS

Apart from these common effects, potential maximum direct, indirect and cumulative effects to cultural resources can be assessed according to the maximum extent within which ground-disturbing activities can potentially occur for each alternative. The principal proposed ground-disturbing activities include: timber, road construction, fire management and recreation. As articulated above, direct ground disturbing effects are estimated to be least in Alternative C and greatest in Alternative D.

Cumulatively, the repeated implementation of these project activities could, over time, result in the degradation of sites, a potential reduction in the number of intact historic properties, and increased site vandalism. However, the standards common to all alternatives are designed to inventory, evaluate, and preserve significant cultural resource values through avoiding, minimizing, or mitigating negative effects of these management activities.

C4 - WILDERNESS AND INVENTORIED ROADLESS AREAS

AFFECTED ENVIRONMENT

Wilderness

The GWNF currently has six designated Wildernesses: Ramseys Draft, Rich Hole, Rough Mountain, Saint Mary's, Three Ridges, and Priest totaling about 40,000 acres or roughly 4% of the forest's area. Small portions of Barbours Creek (20 acres) and Shawvers Run (95 acres) Wildernesses that lie on the GWNF are managed under the revised Jefferson Forest Plan. One area, Saint Mary's Addition, totaling about 1,500 acres, was recommended for designation in the 1993 Forest Plan, but has not been designated. It continues to be managed to retain its wilderness attributes pending congressional action on whether to designate or have the agency study it further.

The Desired Condition is to protect and perpetuate the wilderness character and values of these areas as directed in the Wilderness Act and subsequent Wilderness designating legislation including providing opportunities for solitude, education, physical and mental challenge, inspiration, scientific study and primitive recreation. Wilderness ecosystems are the result of natural succession and natural processes with as little human intervention as possible while retaining wilderness character. There should be little evidence of visitor use and low interaction among users. The few trails and associated facilities present are retained primarily to protect the wilderness resources. No motorized use is permitted. The plan provides specific standards for management of the various resources and activities that are or could potentially occur in the wildernesses including, recreation, fire, lands, minerals, fish and wildlife, insects and disease, research, search and rescue, special uses, and hydrology.

National Scenic Areas

National Scenic Areas are also designated by Congress. Unlike Wilderness, there is no national direction for managing National Scenic Areas. The direction for a National Scenic Area is identified in the designating legislation. The GWNF has one National Scenic Area, Mount Pleasant. The Mount Pleasant National Scenic Area is about 7,700 acres in size. It is managed to: 1) ensure appropriate protection and preservation of the area's scenic quality, water quality, natural characteristics, and water resources; 2) protect and manage vegetation to provide wildlife and fish habitat consistent with item 1; 3) provide areas that may develop characteristics of old growth forests; and 4) provide a variety of recreation opportunities that are consistent with the preceding purposes.

Potential Wilderness Areas

The first step in the evaluation of potential wilderness is to identify and inventory all areas within the National Forest System that satisfy the definition of wilderness. For areas in the Eastern United States (east of the 100th Meridian), the agency's evaluation yields one of the two following options: a) Manage the area for multiple uses other than wilderness; or b) Administratively recommend the area as a Wilderness Study Area to the United States Congress. Congress would then determine whether they want the agency to study any area further.

Final agency guidance (Forest Service Handbook (FSH) 1909.12 Chapter 70) on identifying potential areas was released on January 31, 2007. The methodology used to identify the Potential Wilderness Areas for the GWNF is described in *Guidance on How to Conduct the "Potential Wilderness Area Inventory" for the George Washington National Forest Plan.*

The Forest identified the following 37 areas as Potential Wilderness Areas (Table 3C4-1). Appendix C contains an evaluation of each of these areas in relation to their availability, capability, and the need to be recommended for wilderness study.

Table 3C4-1. Potential Wilderness Areas

Potential Wilderness Name	Total GWNF Acres
Adams Peak	8,226
Archer Knob	7,110
Beards Mountain	10,152
Beech Lick Knob	14,087
Big Schloss	28,347
Crawford Knob	14,851
Dolly Ann	9,524
Duncan Knob	5,973
Elliott Knob	11,070
Galford Gap	6,689
Gum Run	14,547
High Knob	18,447
Jerkemtight	27,314
Kelley Mountain	12,892
Laurel Fork	10,236
Little Alleghany	15,395
Little Mare Mountain	11,918
Little River	30,227
Massanutten North	16,530
Oak Knob - Hone Quarry Ridge	16,343
Oliver Mountain	13,049
Paddy Knob	5,987
Potts Mountain	7,019
Ramseys Draft Addition	19,072
Rich Hole Addition	12,165
Rich Patch	871
Rough Mountain Addition	2,063
Saint Mary's North	3,006
Saint Mary's South	1,651
Saint Mary's West	278
Shaws Ridge	7,268
Shawvers Run Addition	84
Three Ridges Addition North	83
Three Ridges Addition South	187
Three Ridges Addition Southwest	9
Three Ridges Addition West	90
Three Sisters	9,871
TOTAL ACRES	372,631

Inventoried Roadless Areas

During the revision of the Forest Plan completed in 1993, the Forest completed an inventory similar to the Potential Wilderness Areas but identified the areas as Inventoried Roadless Areas. In the late 1990s the Forest Service decided to develop consistent guidance for managing all of the Inventoried Roadless Areas on all National Forests. These Inventoried Roadless Areas became part of the national Roadless Area Conservation Rule (RACR) in 2001. This analysis will address the management options for each of the Inventoried Roadless Areas in addition to the analysis of the Potential Wilderness Areas.

The 1993 GW Plan EIS evaluated 27 inventoried roadless areas totaling more than 260,000 acres. The Plan allocated the roadless areas among the various Management Areas. Three areas, totaling about 12,000 acres were recommended for wilderness study: Saint Mary's Addition, Three Ridges, and Priest. The vast majority of the remaining acreage was allocated to Remote Highlands (121,000 acres), Special Management Areas (60,000 acres), and Special Interest Areas (32,000 acres). The Special Management Areas included Big Schloss, Little River, Laurel Fork, and Mount Pleasant, each with its own Desired Future Condition and standards. According to the 1993 Plan, 89% of the roadless acreage is allocated to management areas which would preserve the roadless character and the remaining 11% could have projects that alter the roadless nature of a given area. However, it should be noted that such projects would not be consistent with the requirements of the 2001 RACR.

Two areas (Southern Massanutten and The Friar) from the 1993 roadless area inventory are not included in the Potential Wilderness Area inventory. The Friar is too small in size (2,051 acres) for it to have any kind of "core" area to provide for a sense of solitude, and Southern Massanutten has about 70 percent of the area underlain by privately owned minerals.

The Inventoried Roadless Areas and their relation to the Potential Wilderness Areas are displayed in Table 3C4-2.

Table 3C4-2. Potential Wilderness Areas and Inventoried Roadless Areas

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres
Adams Peak	8,226	7,282
Archer Knob	7,110	
Beards Mountain	10,152	7,504
Beech Lick Knob	14,087	
Big Schloss	28,347	20,811
Crawford Knob	14,851	9,852
Dolly Ann	9,524	7,866
Duncan Knob	5,973	
Elliott Knob	11,070	9,391
Galford Gap	6,689	
Gum Run	14,547	12,620
High Knob	18,447	12,871
Jerkemtight	27,314	16,849
Kelley Mountain	12,892	7,742
Laurel Fork	10,236	10,053
Little Alleghany	15,395	10,207
Little Mare Mountain	11,918	

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres
Little River	30,227	27,180
Massanutten North	16,530	9,459
Oak Knob - Hone Quarry Ridge	16,343	10,852
Oliver Mountain	13,049	13,089
Paddy Knob	5,987	
Potts Mountain	7,019	
Ramseys Draft Addition	19,072	12,814
Rich Hole Addition	12,165	10,919
Rich Patch	871	
Rough Mountain Add	2,063	1,154
Saint Mary's North	3,006	
Saint Mary's South	1,651	1,478
Saint Mary's West	278	
Shaws Ridge	7,268	
Shawvers Run Addition	84	
Southern Massanutten		12,080
The Friars		2,051
Three Ridges Add North	83	
Three Ridges Add South	187	
Three Ridges Add SW	9	
Three Ridges Add West	90	
Three Sisters	9,871	8,154
TOTAL GWNF ACRES	372,631	242,278

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Wilderness

Wilderness has many positive effects. As stated above, wilderness preserves natural systems and provides places of solitude for visitors. However, there are environmental effects within wilderness from many sources. Recreational use can have negative impacts to the quality, character and integrity of the wilderness resource due to overuse. Some of these negative impacts include soil compaction; vegetation loss due to disturbance and/or replacement by non-native species such as noxious weeds on trails and campsites caused by heavy recreation use; crowding and loss of solitude; deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological/ecological processes and biodiversity, through human disturbance.

Other environmental effects which impact the integrity of the natural systems in wilderness include air pollution from outside sources, interruption of natural functioning ecosystems by fire suppression, and threats to native plant species from the spread of noxious weeds from sources outside wilderness.

No significant new management direction is being proposed for any of the existing six designated wilderness areas on the forest under any of the alternatives so there are no significant direct, indirect, or cumulative

effects to the existing wilderness resource. Additions to existing wildernesses are proposed under some alternatives by allocating adjacent lands to proposed wilderness study areas. See the potential wilderness area discussion below.

National Scenic Areas

Identification of recommended National Scenic Areas (NSAs) is not a requirement of forest planning. However, several areas were identified during scoping for recommendation.

In Alternative D the 8,000-acre Adams Peak area is recommended as an NSA. This would change the area from its current management as Remote Highlands. A small portion of the area that is suitable for timber harvest is excluded from the NSA, so no suitable land is affected by the recommendation.

Alternative F includes three National Scenic Area recommendations: the Virginia portion of Shenandoah Mountain between Highway 33 and Highway 250, Kelley Mountain, and Adams Peak for a total of 128,000 acres.

In Alternatives H and I about 90,000 acres are recommended for designation as a National Scenic Area on Shenandoah Mountain, including just over 22,000 acres of designated and recommended wilderness.

Since the actual management of any NSA would be determined by the legislation, it is assumed for this analysis that the legislation would be similar to that used to designate other NSAs in Virginia.

Designation as a National Scenic Area would likely prevent the construction of roads, the harvest of timber, the development of minerals, and construction associated with special use permits. Non-motorized recreation would continue, including bicycle use and hunting. The use of prescribed fire would be allowed. Designation would likely require survey and posting of the boundary. It would highlight the area and potentially increase use and income to the local community. Any desired future changes in management of the area would require legislation rather than a plan amendment.

Potential Wilderness Areas

Decisions on the Potential Wilderness Areas have environmental consequences, regardless of whether or not they are recommended for wilderness study areas. The magnitude of the effects varies by alternative depending upon the management prescription area to which each area is assigned.

Table 3C4-3 summarizes all Potential Wilderness Area allocations by category across the alternatives. Three categories are used to summarize how each Potential Wilderness Area is allocated in the alternatives. These categories are: 1) Recommended Wilderness Study; 2) Remote Character (includes Remote Backcountry, Recommended National Scenic Area, Shenandoah Mountain Crest - Cow Knob Salamander Area, Special Biological Areas and Wild and Scenic River Corridors); and 3) Other (management prescription areas not designed to maintain the remote character of the area).

Table 3C4-3. Management Prescription Area Allocations within Potential Wilderness Areas (PWAs) and Inventoried Roadless Areas (IRAs)

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within an IRA	Acres of PWA not within an IRA	ALT A			ALT B			ALT C		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Adams Peak (PWA, IRA)	8,200		900			900		900		900		
		7,300			7,200	100		7,300		7,300		
Archer Knob (PWA)	7,100		7,100			7,100			7,100	7,100		
Beards Mountain (PWA, IRA)	10,100		2,600			2,600		2,600		2,600		
		7,500			7,200	300		7,500		7,500		
Beech Lick Knob (PWA)	14,100		14,100			14,100		5,600	8,500	14,100		
Big Schloss (PWA, IRA)	28,300		7,500			7,500			7,500	7,500		
		20,800			20,800			20,800		20,800		
Crawford Knob (PWA, IRA)	14,800		4,900			4,900			4,900	4,900		
		9,900			8,500	1,400		8,600	1,300	9,900		
Dolly Ann (PWA, IRA)	9,500		1,600			1,600			1,600	1,600		
		7,900			4,900	3,000		7,100	800	7,900		
Duncan Knob (PWA)	6,000		6,000			6,000			6,000	6,000		
Elliott Knob (PWA, IRA)	11,100		1,700			1,700			1,700	1,700		
		9,400			8,700	700		9,200	200	9,400		
Galford Gap (PWA)	6,700		6,700			6,700			6,700	6,700		
Gum Run (PWA, IRA)	14,500		1,900			1,900			1,900	1,900		
		12,600			12,500	100		12,600		12,600		
High Knob (PWA, IRA)	18,400		5,600			5,600			5,600	5,600		
- Dry Run (IRA)		7,200			3,500	3,700		6,700	500	7,200		
- Skidmore (IRA)		5,600			5,600			5,600		5,600		
Jerkemtight (PWA, IRA)	27,300		10,500			10,500			10,500	10,500		
		16,800			16,000	800		16,000	800	16,800		
Kelley Mountain (PWA, IRA)	12,900		5,200			5,200			5,200	5,200		
		7,700			7,700			7,700		7,700		
Laurel Fork (PWA, IRA)	10,200		200			200			200	200		
		10,000			10,000			10,000		10,000		

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within an IRA	Acres of PWA not within an IRA	ALT A			ALT B			ALT C		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Little Alleghany (PWA, IRA)	15,400		5,200			5,200			5,200	5,200		
		10,200			7,200	3,000		9,500	700	10,200		
Little Mare Mountain (PWA)	11,900		11,900			11,900			11,900	11,900		
Little River (PWA, IRA)	30,200		3,000			3,000			3,000	3,000		
		27,200			26,100	1,100	9,300	16,900	1,000	27,200		
Massanutten North (PWA, IRA)	16,500		7,000			7,000			7,000	7,000		
		9,500			9,300	200		9,500		9,500		
Oak Knob-Hone Quarry Ridge (PWA, IRA)	16,300		5,500			5,500			5,500	5,500		
		10,800			9,400	1,400		10,000	800	10,800		
Oliver Mountain (PWA, IRA)	13,100											
		13,100			13,100			13,100		13,100		
Paddy Knob (PWA)	6,000		6,000			6,000			6,000	6,000		
Potts Mountain (PWA)	7,000		7,000			7,000			7,000	7,000		
Ramseys Draft Add. (PWA, IRA)	19,100		6,300			6,300			6,300	6,300		
		12,800			12,700	100	6,100	6,700	0	12,800		
Rich Hole Addition (PWA, IRA)	12,200		1,300			1,300			1,300	1,300		
		10,900			7,600	3,300	4,700	4,700	1,500	10,900		
Rich Patch (PWA)	900		900			900			900	900		
Rough Mountain Add. (PWA, IRA)	2,100		900			900			900	900		
		1,200				1,200		1,200		1,200		
St Mary's North (PWA)	3,000		3,000			3,000			3,000	3,000		
St Mary's South (PWA, IRA)	1,700		200			200			200	200		
		1,500		1,500				1,500		1,500		
St Mary's West (PWA)	300		300			300	300			300		

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within an IRA	Acres of PWA not within an IRA	ALT A			ALT B			ALT C		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Shaws Ridge (PWA)	7,300		7,300			7,300			7,300	7,300		
Shawvers Run Add (PWA)	100		100			100			100	100		
Three Ridges Add North (PWA)	100		100			100			100	100		
Three Ridges Add South (PWA)	200		200			200			200	200		
Three Ridges Add SW (PWA)	9		9			9			9	9		
Three Ridges Add West (PWA)	100		100			100			100	100		
Three Sisters (PWA, IRA)	9,900		1,700			1,700			1,700	1,700		
		8,200			8,200			8,200	0	8,200		
Southern Massanutten (IRA), not a PWA	N/A											
		12,100			12,100			12,100		12,100		
The Friars (IRA), not a PWA	N/A											
		2,000			2,000			2,000		2,000		
Whites Peak, not a PWA or IRA	N/A											
		N/A	4,200		4,200			4,200			4,200	
TOTAL ACRES IN ALL AREAS	372,609	242,200	148,709	1,500	224,500	164,909	20,400	227,800	142,709	386,709	4,200	0

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within IRA	Acres of PWA not within IRA	ALT D			ALT E			ALT F		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Adams Peak (PWA, IRA)	8,200		900		900			100	800		900	
		7,300			7,300			7,300			7,300	
Archer Knob (PWA)	7,100		7,100			7,100		7,100				7,100
Beards Mountain (PWA, IRA)	10,100		2,600		800	1,800		2,600			800	1,800
		7,500			7,500			7,500			7,500	
Beech Lick Knob (PWA)	14,100		14,100		5,600	8,500		14,100		11,600	2,500	
Big Schloss (PWA, IRA)	28,300		7,500		200	7,300		200	7,300		7,500	
		20,800			20,800			20,800		7,200	13,600	
Crawford Knob (PWA, IRA)	14,800		4,900			4,900		2,500	2,400		2,500	2,400
		9,900			8,500	1,400		9,900			9,900	
Dolly Ann (PWA, IRA)	9,500		1,600			1,600		500	1,100		500	1,100
		7,900			7,300	600		7,900			7,900	
Duncan Knob (PWA)	6,000		6,000		100	5,900		3,700	2,300		4,700	1,300
Elliott Knob (PWA, IRA)	11,100		1,700			1,700			1,700		1,700	
		9,400			9,400			9,400			9,400	
Galford Gap (PWA)	6,700		6,700			6,700			6,700		6,700	
Gum Run (PWA, IRA)	14,500		1,900		500	1,400		1,900			1,900	
		12,600			12,600			12,600			12,600	
High Knob (PWA, IRA)	18,400		5,600		300	5,300		5,600			5,600	
- Dry Run (IRA)		7,200			7,200			7,200			7,200	
- Skidmore (IRA)		5,600			5,600			5,600		5,600		
Jerkemtight (PWA, IRA)	27,300		10,500		100	10,400		6,200	4,300		6,200	4,300
		16,800			16,100	700		16,800			16,800	
Kelley Mountain (PWA, IRA)	12,900		5,200		4,900	300		4,900	300		4,900	300
		7,700			7,700			7,700			7,700	
Laurel Fork (PWA, IRA)	10,200		200		200			200		200		
		10,000			10,000			10,000		10,000		

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within IRA	Acres of PWA not within IRA	ALT D			ALT E			ALT F		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Little Alleghany (PWA, IRA)	15,400		5,200			5,200			5,200	5,200		
		10,200			9,100	1,100		9,100	1,100	10,200		
Little Mare Mountain (PWA)	11,900		11,900		200	11,700		11,900			6,500	5,400
Little River (PWA, IRA)	30,200		3,000		600	2,400		3,000			600	2,400
		27,200			27,200		12,700	14,500		12,700	14,500	
Massanutten North (PWA, IRA)	16,500		7,000		2,000	5,000		2,000	5,000		2,000	5,000
		9,500			9,500			9,500			9,500	
Oak Knob-Hone Quarry Ridge (PWA, IRA)	16,300		5,500		1,100	4,400		5,500			5,500	
		10,800			9,600	1,200		10,800			10,800	
Oliver Mountain (PWA, IRA)	13,100											
		13,100			13,100			13,100		8,700	4,400	
Paddy Knob (PWA)	6,000		6,000		900	5,100		900	5,100		6,000	
Potts Mountain (PWA)	7,000		7,000			7,000		7,000		4,200	2,800	
Ramseys Draft Add. (PWA, IRA)	19,100		6,300		800	5,500		1,600	4,700		6,300	
		12,800			12,800		3,100	9,700		12,400	400	
Rich Hole Addition (PWA, IRA)	12,200		1,300			1,300			1,300	200	1,100	
		10,900		4,700	4,700	1,500	4,700	4,700	1,500	10,900		
Rich Patch (PWA)	900		900		900			900			900	
Rough Mountain Add. (PWA, IRA)	2,100		900		100	800	900			900		
		1,200			1,200		1,200			1,200		
St Mary's North (PWA)	3,000		3,000		3,000			3,000			3,000	
St Mary's South (PWA, IRA)	1,700		200		200		200			200		
		1,500			1,500		1,500			1,500		
St Mary's West (PWA)	300		300	200	100		200	100		200	100	
Shaws Ridge (PWA)	7,300		7,300		100	7,200		7,300			7,300	

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within IRA	Acres of PWA not within IRA	ALT D			ALT E			ALT F		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Shawvers Run Add (PWA)	100		100		100			100			100	
Three Ridges Add North (PWA)	100		100		100			100		100		
Three Ridges Add South (PWA)	200		200		200			200		200		
Three Ridges Add SW (PWA)	9		9		9			9		9		
Three Ridges Add West (PWA)	100		100		100			100		100		
Three Sisters (PWA, IRA)	9,900		1,700		600	1,100		200	1,500		1,700	
		8,200		5,500	2,700			8,200		5,500	2,700	
Southern Massanutten (IRA), not a PWA	N/A											
		12,100			12,100			12,100			12,100	
The Friars (IRA), not a PWA	N/A											
		2,000			2,000			2,000			2,000	
Whites Peak, not a PWA or IRA	N/A											
		N/A	4,200	4,200				4,200		4,200		
TOTAL ACRES IN ALL AREAS	372,609	242,200	148,709	14,600	250,209	126,100	24,500	314,109	52,300	113,209	246,600	31,100

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within IRA	Acres of PWA not within IRA	ALT G			ALTS H and I		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Adams Peak (PWA, IRA)	8,200		900		100	800		100	800
		7,300			7,300			7,300	
Archer Knob (PWA)	7,100		7,100		4,900	2,200		5,100	2,000
Beards Mountain (PWA, IRA)	10,100		2,600		800	1,800		800	1,800
		7,500			7,500			7,500	
Beech Lick Knob (PWA)	14,100		14,100		8,300	5,800	5,700	3,500	4,900
Big Schloss (PWA, IRA)	28,300		7,500		200	7,300		200	7,300
		20,800			20,800			20,800	
Crawford Knob (PWA, IRA)	14,800		4,900			4,900			4,900
		9,900			9,900			9,900	
Dolly Ann (PWA, IRA)	9,500		1,600		500	1,100		500	1,100
		7,900			7,900			7,900	
Duncan Knob (PWA)	6,000		6,000		3,400	2,600		3,400	2,600
Elliott Knob (PWA, IRA)	11,100		1,700			1,700			1,700
		9,400			9,400	0		9,400	
Galford Gap (PWA)	6,700		6,700			6,700			6,700
Gum Run (PWA, IRA)	14,500		1,900		1,900			1,900	
		12,600			12,600			12,600	
High Knob (PWA, IRA)	18,400		5,600		1,500	4,100		1,500	4,100
- Dry Run (IRA)		7,200			7,200			7,200	
- Skidmore (IRA)		5,600			5,600			5,600	
Jerkemtight (PWA, IRA)	27,300		10,500		6,800	3,700		5,500	5,000
		16,800			16,800			16,800	
Kelley Mountain (PWA, IRA)	12,900		5,200		2,400	2,800		2,400	2,800
		7,700			7,700			7,700	
Laurel Fork (PWA, IRA)	10,200		200		200			200	
		10,000			10,000			10,000	

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within IRA	Acres of PWA not within IRA	ALT G			ALTS H and I		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Little Alleghany (PWA, IRA)	15,400		5,200		100	5,100		100	5,100
		10,200			10,200			10,200	
Little Mare Mountain (PWA)	11,900		11,900		4,500	7,400		4,500	7,400
Little River (PWA, IRA)	30,200		3,000		1,500	1,500		1,500	1,500
		27,200		9,300	17,900		9,500	17,700	
Massanutten North (PWA, IRA)	16,500		7,000		2,000	5,000		2,000	5,000
		9,500			9,500			9,500	
Oak Knob-Hone Quarry Ridge (PWA, IRA)	16,300		5,500		5,500			5,500	
		10,800			10,800			10,800	
Oliver Mountain (PWA, IRA)	13,100								
		13,100			13,100			13,100	
Paddy Knob (PWA)	6,000		6,000		900	5,100		900	5,100
Potts Mountain (PWA)	7,000		7,000			7,000			7,000
Ramseys Draft Add. (PWA, IRA)	19,100		6,300		2,900	3,400		900	5,400
		12,800		6,100	6,700		6,100	6,700	
Rich Hole Addition (PWA, IRA)	12,200		1,300		200	1,100		200	1,100
		10,900		4,700	6,200		4,600	6,300	
Rich Patch (PWA)	900		900		900			900	
Rough Mountain Add. (PWA, IRA)	2,100		900			900		100	800
		1,200			1,200		1,000	200	
St Mary's North (PWA)	3,000		3,000		3,000			3,000	
St Mary's South (PWA, IRA)	1,700		200			200			200
		1,500			1,500			1,500	
St Mary's West (PWA)	300		300						
				300			300		
Shaws Ridge (PWA)	7,300		7,300		7,300			7,300	

Potential Wilderness Area Name	Total PWA Acres	Acres of PWA within IRA	Acres of PWA not within IRA	ALT G			ALTS H and I		
				Recomm Wild Ac	Remote Ac	Other Ac	Recomm Wild Ac	Remote Ac	Other Ac
Shawvers Run Add (PWA)	100		100		100			100	
Three Ridges Add North (PWA)	100		100		100			100	
Three Ridges Add South (PWA)	200		200		200			200	
Three Ridges Add SW (PWA)	9		9		9			9	
Three Ridges Add West (PWA)	100		100		100			100	
Three Sisters (PWA, IRA)	9,900		1,700		200	1,500		200	1,500
		8,200			8,200			8,200	
Southern Massanutten (IRA), not a PWA	N/A								
		12,100			12,100			12,100	
The Friars (IRA), not a PWA	N/A								
		2,000			2,000			2,000	
Whites Peak, not a PWA or IRA	N/A								
		N/A	4,200		4,200			4,200	
TOTAL ACRES IN ALL AREAS	372,609	242,200	148,709	20,400	286,809	83,700	27,200	277,909	85,800

Potential Wilderness Areas That are Recommended for Wilderness Study

Allocation of Potential Wilderness Areas (PWAs), or portions of these areas, to Recommended Wilderness Study would increase the number of areas managed to allow natural processes to occur, provide for solitude and primitive recreation, and minimize the impacts of man and his activities on the land. Like wilderness, these are areas where the naturalness, undeveloped conditions, and representative ecosystems would be preserved. The highest priority for management would be to preserve the characteristics of the area that resulted in its consideration for wilderness study, pending actual wilderness designation. Recommended Wilderness Study Areas are not available for activities such as vegetative management or road construction. Pending actual wilderness designation, existing roads and trails and wildlife openings can be maintained using motorized equipment and bicycles can continue to use trails in these areas.

The remainder of this section describes the effects that would occur if the areas were designated as wilderness by Congress. Potential Wilderness Areas and Inventoried Roadless Areas recommended for wilderness study are displayed by alternative in Table 3C4-4.

Table 3C4-4. Numbers of Areas and Acres Allocated to Recommended Wilderness Study by Alternative

Potential Wilderness Area	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Adams Peak			8,226					
Archer Knob			7,110					
Beards Mountain			10,152					
Beech Lick Knob			14,087			11,600		5,730
Big Schloss			28,347			7,218		
Crawford Knob			14,851					
Dolly Ann			9,524					
Duncan Knob			5,973					
Elliott Knob			11,070					
Galford Gap			6,689					
Gum Run			14,547					
High Knob			18,447			5,617		
Jerkemtight			27,314					
Kelley Mountain			12,892					
Laurel Fork			10,236			10,236		
Little Alleghany			15,395			15,395		
Little Mare Mountain			11,918					
Little River		9,348	30,227		12,657	12,657	9,348	9,545
Massanutten North			16,530					
Oak Knob - Hone Quarry Ridge			16,343					
Oliver Mountain			13,049			8,712		
Paddy Knob			5,987					
Potts Mountain			7,019			4,183		
Ramseys Draft Addition		6,114	19,072		3,130	12,412	6,114	6,146
Rich Hole Addition		4,703	12,165	4,703	4,703	11,169	4,714	4,629
Rich Patch			871					
Rough Mountain Add			2,063		2,063	2,063		1,028
Saint Mary's North			3,006					
Saint Mary's South	1,478		1,651		1,651	1,654		

Potential Wilderness Area	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Saint Mary's West		278	278	179	178	179	278	278
Shaws Ridge			7,268					
Shawvers Run Addition			84					
Southern Massanutten			12,080					
The Friars			2,051					
Three Ridges Add North			83			83		
Three Ridges Add South			187			187		
Three Ridges Add SW			9			9		
Three Ridges Add West			90			90		
Three Sisters			9,871	5,549		5,549		
Whites Peak				4,255		4,255		
Total	1,478	20,443	386,762	14,686	24,382	113,268	20,454	27,356

Alternative C recommends all of the PWAs and Southern Massanutten and the Friars Inventoried Roadless Areas (IRAs) for Wilderness Study Areas. This would result in about 40 percent of the GWNF in wilderness. A large cluster of Recommended Wilderness Study Areas would be located near the center of the GWNF. The largest recommended wilderness in this cluster is Little River at about 30,000 acres in size. It is separated by a Forest Service Road from Ramseys Draft Addition (about 25,000 acres). Four other PWAs (Shaws Ridge, Gum Run, Oak Knob/Hone Quarry Ridge, and High Knob) are also in this cluster, each separated by existing roads. The total acreage of recommended Wilderness in this cluster would be about 110,000 acres. Alternative C would also recommend 5 areas on the northern end of the Forest closest to Northern Virginia and Washington, where there are currently no wilderness areas.

Alternatives B, E, G, H and I focus on recommending stand-alone wilderness areas and wilderness area additions that could result in wilderness areas of a size and scale where natural processes can begin to be the dominant influence in the areas.

Alternative F was based on recommendations from a number of wilderness advocacy groups and individuals. Many of the Potential Wilderness Area boundaries were adjusted to exclude important bicycle trails, roads and other uses that would otherwise be prohibited with wilderness designation. This alternative could result in about 14 percent of the GWNF in wilderness.

Table 3C4-5 displays the ecological subsections represented currently by designated wilderness on the forest as well as those that could potentially be added if recommended Wildernesses are designated by Congress.

Table 3C4-5. Ecological Sections/Subsections represented by Wilderness or Recommended Wilderness Study areas by Alternative, acres

Ecological Section/ Subsection	Existing Wild-erness	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
M221Da - Blue Ridge Section/Northern Blue Ridge Subsection	111,215	1,478	278	38,344	9,983	1,829	12,006	278	278
M221Aa - Northern Ridge and Valley Section/ Ridge and Valley Subsection	86,090	0	20,490	283,226	4,703	22,553	83,329	20,490	27,000
M221Ab - Northern Ridge and Valley Section/Great Valley of Virginia	0	0	0	34,583	0	0	0	0	0
M221Bd - Allegheny Mountains Section/Eastern Allegheny Mountain and Valley	11,174	0	0	20,374	0	0	7,698	0	0
M221Ba – Allegheny Mountains Section/Northern High Allegheny Mountain	56,913	0	0	10,236	0	0	10,236	0	0

Direct effects of managing wilderness study areas include maintaining soil, hydrologic and atmospheric conditions prevailing within the areas. Roads would be a priority for closure and rehabilitation or a return to a natural state. This would reduce motorized access to parts of the national forest which would reduce satisfaction of visitors with limited mobility such as families with young children, senior citizens, and people with mobility disabilities. The satisfaction of people seeking remote settings and personal challenge would increase. Water quality and air quality would remain high and the imprint of human influence would generally diminish over time.

If the recommended wilderness study areas become designated wilderness, opportunities for primitive and unconfined recreation will increase, including settings that offer solitude and remoteness due to road decommissioning. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, fishing, and hunting would continue. Motorized and mechanized transport, including mountain bicycling and use of wheeled carts by hunters, would be prohibited.

Table 3C4-6 shows, by alternative, the miles of system trail that would be closed to bicycle use if the recommended wilderness study areas are designated as wilderness.

Table 3C4-6. Miles of Trails to be Closed to Bicycles by Alternative if Recommended Wilderness Study Areas become Wilderness

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Trails to be closed to bicycles	0	9	434	1	11	70	9	9

Bicycles are also allowed on closed roads across the GWNF, unless otherwise specified. Table 3C4-7 enumerates miles of road that would be decommissioned. Alternative C would close the highest number of

miles, about 156 in 16 separate areas. Alternative D would close about 26 miles of road that may currently be used by mountain bicycles and motorized vehicles. Alternatives A, B, G, H and I would result in the least miles of road closed to these uses as a result of wilderness designation.

Table 3C4-7. Miles of Road to be Closed by Alternative
if Recommended Wilderness Study Areas become Wilderness

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Roads to be decommissioned	0	2	155	6	4	26	2	4

Within wilderness study areas that are recommended by Congress as Wilderness, maintenance of trails and facilities, including the Appalachian National Scenic Trail and associated shelters sites would be done using hand tools only and access would be made using non-mechanized/non-motorized means. Currently competitive events are held on some of the trails on the GWNF. These would not be allowed on the sections of trail in designated wilderness. Current recreation events would only be affected in Alternative C.

Additional wilderness would potentially increase National Forest visitation (Cordell 1999). Between 1994 and 2009, the national participation rate for visiting a wilderness increased by 15% and the total activity days increased by almost 32%. Using three scenarios for projecting recreation use, indexed per capita participation rates for visiting a wilderness, primitive camping or backpacking is estimated to increase from 0.383 in 2008 to about 0.947 to 0.995 in 2060 (Cordell 2012). The anticipated increase in visitation would increase economic benefits resulting from tourism in the surrounding local communities. This would be greatest with Alternatives C and F, and have the least economic benefits with Alternatives A and D.

However, there would also be a reduction in economic benefits associated with the management, harvesting, manufacturing and retail sale of timber products from the areas that currently are suitable for timber production; a reduction in local tourism associated specifically with recreation special events such as endurance races that are not permitted in wilderness; and a reduction in local contracting of road maintenance and repairs where roads will be decommissioned. There would be reduced opportunities to recover commercial minerals and mineral exploration and development will be hindered. Specific analysis of net public values between all of the alternatives is provided in this chapter at Section C12.

Table 3C4-8. Effects of Wilderness Designation on Timber and Mineral Resources

Category	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
	Acres Recommended for Wilderness Study							
Lands Tentatively Suitable for Timber Production	1,116	19,182	346,329	12,739	22,645	106,273	19,182	23,838
Lands Identified as Suitable for Timber Production in 1993 Forest Plan	0	1,202	78,278	1,485	2,688	20,350	1,202	3,873
Lands Underlain with Privately Owned Minerals	253	0	37,280	581	2,956	9,976	0	0

As shown in Table 3C4-8, Alternative C has by a large margin the greatest amount of acreage and number of areas with privately owned subsurface mineral rights. Requests for access to these interests would be recognized and reasonable access granted. The potential for development of energy minerals and other leasable and common minerals is estimated to be low, but if gas deposits in the Marcellus shale on the GWNF

are found to be sufficient for development, this could change. While road construction and structures associated with minerals development are inconsistent with managing an area for wilderness values, reasonable access would have to be granted to those owning the subsurface mineral rights. If this were to occur, the wilderness resource would be negatively impacted.

There are no existing federal oil or gas leases or other Federal mineral leases in effect in any of the areas recommended for wilderness study. These areas will be administratively unavailable for federal oil and gas and other federal mineral leases, pending final congressional action. These areas will not be available for mineral materials for commercial purposes. Administrative use of mineral materials is allowed but use and impacts would be extremely low.

Wilderness areas that have extensive boundaries adjacent to private lands can cause management problems. This reduces access to the area for the general forest user and for Forest Service managers. Unauthorized uses, such as ATV trails, other trails, clearing and temporary or permanent structures can occur, with very limited opportunities to find or correct the problems. It can also exacerbate fire and rescue needs in the wilderness area. The areas recommended for wilderness study with the greatest boundary concerns are displayed in Table 3C4-9.

Table 3C4-9. Private Land Boundaries (Miles and Percent of the Perimeter) on Recommended Wilderness Study by Alternative

	Alt A		Alt B		Alt C		Alt D		Alt E		Alt F		Alt G		Alts H and I	
PWA Name	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%
Adams Peak					21.2	68%										
Archer Knob					6.2	22%										
Beards Mountain					26.3	70%										
Beech Lick Knob					19.5	51%					14.7	47%			1.1	8%
Big Schloss (Three High Heads in Alt F)					23.1	35%					1.2	6%				
Crawford Knob					20.0	58%										
Dolly Ann					11.8	54%										
Duncan Knob					9.2	44%										
Elliott Knob					2.7	9%										
Galford Gap					16.3	66%										
Gum Run					17.8	50%										
High Knob					14.2	28%					2.8	14%				
Jerkemtight					14.9	21%										
Kelley Mountain					6.8	21%										
Laurel Fork					16.9	77%					16.9	77%				
Little Alleghany					39.0	75%					39.0	75%				
Little Mare Mountain					12.2	33%										
Little River			0	0%	8.1	21%	1.2	6%	1.2	6%	1.2	6%	0%	0%	0%	0%
Massanutten North					48.6	69%										
Oak Knob - Hone Quarry					4.7	15%										
Oliver Mountain					34.3	77%					27.3	79%				

	Alt A		Alt B		Alt C		Alt D		Alt E		Alt F		Alt G		Alts H and I	
PWA Name	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%	Miles	%
Paddy Knob					9.8	50%										
Potts Mountain					11.0	32%					2.1	14%				
Ramseys Draft Add.			0	0%	10.2	19%			0%	0%	6.5	34%	0%	0%	0%	0%
Rich Hole Addition			3.8	29%	12.9	36%	3.8	29%	3.8	29%	12.9	35%	3.8	29%	3.8	29%
Rich Patch					9.1	37%										
Rough Mountain Add.					5.4	54%			5.4	54%	5.4	54%			0.8	13%
Saint Mary's North					0.7	6%										
Saint Mary's South	2.0	19%			5.9	56%			5.9	56%	5.9	56%				
Saint Mary's West			0.5	19%	0.5	19%	0.5	19%	0.5	19%	0.5	19%	0.5	19%	0.5	19%
Shaws Ridge					26.4	87%										
Shawvers Run Add.					0.6	32%										
Southern Massanutten																
The Friars																
Three Ridges Add. N					0.8	33%					0.8	33%				
Three Ridges Add. S					1.6	51%					1.6	51%				
Three Ridges Add. SW					0.3	40%					0.3	40%				
Three Ridges Add. W					1.1	65%					1.1	65%				
Three Sisters					5.7	30%	5.0	29%			5.0	29%				
Whites Peak							9.4	58%			9.4	58%				

The naturalness, uniqueness, and representative ecosystems of the designated areas would be maintained. Natural ecological processes would continue, including plant succession. Larger blocks of undeveloped land and reduction in open road density in areas recommended for wilderness study will favor area sensitive and disturbance sensitive species. Existing old fields, wildlife openings and other habitat improvements for fish and wildlife would not be maintained after congressional designation. New permanent wildlife openings would not be created. Habitat for early successional species will decrease. Fish stocking would emphasize reestablishment or maintenance of indigenous, threatened, endangered, or sensitive species. Rare communities and threatened and endangered species would be managed within the limitation of activities allowed within wilderness study areas.

Some of the areas contain threatened, endangered or sensitive (TES) species, rare plants or rare communities. The significance of the effects on these resources depends upon the number of areas and the kinds and intensity of activities in the areas. Wilderness designation can have mixed effects on these resources. Designation prevents many types of activities (such as road construction, habitat manipulation, mineral developments, special use development) that could adversely affect the resources. Designation can also prevent, or significantly increase the cost and efficacy of, management activities that could enhance habitat conditions for these resources. Many rare communities need, or are enhanced by, fire. The use of prescribed fire in wilderness is limited, so species that need fire would likely only be enhanced by wildfires. In addition, several of the areas contain acidified streams. Treating acidified streams in wilderness, is possible, but requires additional analysis during project level NEPA and it requires authorization by the Regional Forester. Table 3C4-10 provides information about the vegetative communities, TES species, acidified streams and special biological areas that could be affected by Wilderness designation for each of the alternatives.

Table 3C4-10. Effects on Wildlife and Vegetation Communities by Alternative if Recommended Wilderness Study Areas become Wilderness

Alternative	Area Supporting Table Mountain Pine, (Acres)	Presence of TESLR species, that DO NOT need active management	Area contains TES and/or FS sensitive species or habitat enhanced by human intervention or disturbance	Presence of Acidified streams	Special Biological Areas (Acres)
A	0	None	None	No	0
B	473	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander	Yes, 2 areas	7,379
C	14,234	Cow Knob Salamander, Swamp pink, Waterfan lichen, Va northern flying squirrel, Southern water shrew, NE bulrush, McGraw Gap xystodesmid, Rock skullcap, Roughhead shiner, Virginia sneezeweed, Bald eagle, Southern water shrew, Southern rock vole	Barrens tiger beetle, Sword leaved phlox, Turkey beard, coal skink; Big Levels salamander, Millboro leatherflower, Pearly everlasting, Ground juniper, Phlox buckleyi, App grizzled skipper, Smooth coneflower, Shale barren rockcress; Sand grape, Phlox buckleyi, Plains frostweed, N. bristly sarsaparilla, Least trillium, Slender wheatgrass, Mountain paper birch, Wild chess, Variable sedge, Bristly black currant, Morning Warbler, Pirate bush	Yes, 14 areas	64,595
D	22	Swamp pink	Big Levels salamander	Yes, 1 area	101

Alternative	Area Supporting Table Mountain Pine, (Acres)	Presence of TESLR species, that DO NOT need active management	Area contains TES and/or FS sensitive species or habitat enhanced by human intervention or disturbance	Presence of Acidified streams	Special Biological Areas (Acres)
E	796	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander, Millboro leatherflower	Yes, 2 areas	4,312
F	3,964	Cow Knob Salamander, Swamp pink, NE bulrush, Waterfan lichen, Va northern flying squirrel, Southern water shrew; McGraw Gap xystodesmid, Rock skullcap	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink, Big Levels salamander; Millboro leatherflower; Pearly everlasting, Ground juniper, Phlox buckleyi, App grizzled skipper, Smooth coneflower, Shale barren rockcress	Yes, 6 areas	18,412
G	473	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander	Yes, 2 areas	7,379
H and I	876	Cow Knob Salamander, Swamp pink	Barrens tiger beetle, Sword leaved phlox, Turkey beard, Mtn paper birch, coal skink; Big Levels salamander	Yes, 2 areas	7,379

Educational opportunities for the scientific study of natural ecological processes would increase.

Fire management may be affected by designation of additional wilderness areas. Under emergency situations, mechanized equipment and motorized transport, use of helicopters, air tankers, and other aircraft may be approved by the Forest Supervisor and/or Regional Forester. These actions would impact wilderness character and visitor experiences and leave evidence of man, although rehabilitation could help to reduce those impacts afterward.

Lightning-ignited fires, if allowed to burn, enhance the natural systems that are fire-dependent. It would benefit recreation by opening up the forest, reducing fuel loading to acceptable levels, and maintaining the vegetation. There would be a short-term negative impact to air quality, visual aesthetics and possibly water quality.

Several of the areas have a history of wildland fire, either naturally ignited or human-caused. All or a portion of the acres in each of these areas would be included in the Forest's planned prescribed burning program. A Recommended Wilderness Study designation would likely limit this management activity.

Additional human-caused effects to wilderness study areas are similar to those found in wilderness such as soil compaction; vegetation loss or disturbance; non-native species introduction; crowding and loss of solitude; deterioration of water quality from improper disposal of human waste and waste water; and loss of or threats to biological/ecological processes and biodiversity, through human disturbance.

Potential Wilderness Areas Managed to Retain Their Remote Character

In the alternatives, some of the Potential Wilderness Areas, or portions of these areas, are allocated to management prescription areas that will retain the characteristics of the area that made them qualify as a

Potential Wilderness Areas. Due to management direction in the Forest Plan, these remote areas would still qualify during the next forest plan revision for placement on the Potential Wilderness Area Inventory according to final agency guidance (Forest Service Handbook (FSH) 1909.12 Chapter 70). In other words, future options for recommending these areas as wilderness study will not be forgone. Alternative prescriptions that would maintain the remote character of these areas include Recommended Wilderness Study Area (1B), Remote Backcountry (12D), Recommended National Scenic Area (4FA), Research Natural Area (4B), Shenandoah Mountain Crest (8E7), and large blocks of Special Biological Areas (4D), like Kelley Mountain. These management prescription areas are all unsuitable for timber production. The biggest factor contributing to an area retaining the qualities to meet the PWA inventory is a restriction or prohibition on road construction.

In Alternative A, the Remote Backcountry prescription prohibits road construction with some exceptions to provide for site-specific needs. Examples of these exceptions where new road construction could be allowed include: 1) to access approved mineral activities; (2) where the new road is the only prudent alternative to serve resource needs in adjacent management areas and it will minimally impact this management area; (3) to relocate existing roads; (4) to provide access to trailheads; or (5) to provide access to private land if no other route is feasible.

In Alternatives B, C, D, E, F, G, H and I, roads may not be constructed or reconstructed in the Remote Backcountry prescription areas unless:

(1) A road is needed to protect public health and safety in cases of an imminent threat of flood, fire, or other catastrophic event that, without intervention, would cause the loss of life or property;

(2) A road is needed to conduct a response action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or to conduct a natural resource restoration action under CERCLA, Section 311 of the Clean Water Act, or the Oil Pollution Act;

(3) A road is needed pursuant to reserved or outstanding rights, or as provided for by statute or treaty;

(4) Road realignment is needed to prevent irreparable resource damage that arises from the design, location, use, or deterioration of a system road that cannot be mitigated by road maintenance. Road realignment may occur under this paragraph only if the road is deemed essential for public or private access, natural resource management, or public health and safety;

(5) Road reconstruction is needed to implement a road safety improvement project on a system road determined to be hazardous on the basis of accident experience or accident potential on that road;

(6) The Appropriate Decision-maker (Secretary of Agriculture for Inventoried Roadless Areas) determines that a Federal Aid Highway project, authorized pursuant to Title 23 of the United States Code, is in the public interest or is consistent with the purposes for which the land was reserved or acquired and no other reasonable and prudent alternative exists; or

(7) A road is needed in conjunction with the continuation, extension, or renewal of a mineral lease on lands that are under lease or for a new lease issued immediately upon expiration of an existing lease. Such road construction or reconstruction must be conducted in a manner that minimizes effects on surface resources, prevents unnecessary or unreasonable surface disturbance, and complies with all applicable lease requirements, land and resource management plan direction, regulations, and laws. Roads constructed or reconstructed pursuant to this paragraph must be obliterated when no longer needed for the purposes of the lease or upon termination or expiration of the lease, whichever is sooner.

In Alternatives B, C, D, E, F, G, H and I, timber harvest is restricted in the Remote Backcountry prescription areas as follows:

Timber may not be cut, sold, or removed, except as provided in (a).

(a) Timber may be cut, sold, or removed if one of the following circumstances exists. The cutting, sale, or removal of timber in these areas is expected to be infrequent.

(1) The cutting, sale, or removal of generally small diameter timber is needed for one of the following purposes and will maintain or improve one or more of the remote area characteristics;

(i) To improve threatened, endangered, proposed, or sensitive species habitat; or

(ii) To maintain or restore the characteristics of ecosystem composition and structure, such as to reduce the risk of uncharacteristic wildfire effects, within the range of variability that would be expected to occur under natural disturbance regimes of the current climatic period;

(2) The cutting, sale, or removal of timber is incidental to the implementation of a management activity not otherwise prohibited; or

(3) The cutting, sale, or removal of timber is needed and appropriate for personal or administrative use.

In Alternatives B and D, one additional exception where timber harvest would be allowed in the Remote Backcountry prescription area is as follows:

Or (4) Salvage of dead and dying trees is needed and the remote character of the area is not impaired by the harvest activity.

In Alternative D the Remote Backcountry portion of Beech Lick Knob is not identified as unsuitable for wind development. A proposal for wind energy development in that area could be accepted for analysis. If approved, wind turbines, associated transmission lines and access roads could be constructed. This is an exception to the above prohibitions on management.

Areas managed for their remote character would provide opportunities for solitude and remoteness. Non-motorized dispersed recreation activities such as hiking, horseback riding, camping, mountain biking, fishing, and hunting would continue and use levels would be expected to remain about the same as currently takes place. Maintenance of trails and facilities, including the Appalachian Trail and associated shelters sites would be done using current mechanized and non-mechanized means. Current competitive events would continue.

Mineral leasing would be constrained with No Surface Use stipulations.

Existing access would continue to provide for fire and rescue needs, law enforcement needs, other resource management needs and public access.

Natural ecological processes would continue including plant succession. Larger blocks of undeveloped land and existing low open road density will favor area sensitive and disturbance sensitive species. However, prescribed fire and maintenance of existing old fields, wildlife openings and other habitat improvements for fish and wildlife will continue to provide some habitat for early successional species and species that need open woodland conditions. Habitat improvements for TES species, rare plants or rare communities can be completed.

Potential Wilderness Areas Managed for Other Resources

With the exception of Alternative C, the alternatives allocate some of the Potential Wilderness Areas, or portions of these areas, to other management prescription areas that emphasize resources other than recreation and remote backcountry. See Table 3C4-3 for acres of Potential Wilderness Areas that are allocated to “Other Acres”. These management prescription areas may allow timber harvesting, mineral development that involves surface occupancy, changes in land ownership pattern, or construction of improvements like buildings, fences, roads, transmission lines, communication installations, and/or campgrounds. PWAs or portions of PWAs where these activities occur may not meet the PWA inventory criteria for the next GWNF plan

revision. Management prescription allocations in a Forest Plan do not necessarily commit an area to development. Before a decision is made to conduct one of these activities (for example: build a road or harvest timber in a Potential Wilderness Area), a site-specific analysis must be conducted.

Based on the data in Table 3C4-3, Alternative C provides for protection of all acres of Potential Wilderness Areas. Alternatives F, G, H and I follow with potential impacts to 31,300, 87,800 and 88,700 acres respectively where the PWA inventory criteria could be affected. Alternatives A and B provide the least protection of Potential Wilderness Areas, with potential impacts to 147,509 and 138,109 acres respectively.

With active management through road construction in these areas, the remote character may be diminished over time. The naturalness of these areas may be reduced. Vegetation composition and structure may be manipulated resulting in a greater diversity of age-classes among forest types. Opportunities for solitude and remoteness may decrease. Sights and sounds of human activities may be more obvious. Additional roads and trails may be constructed. Noise levels and soil erosion may increase and air and water quality may decrease but water quality will meet State and Federal standards.

Inventoried Roadless Areas

The Inventoried Roadless Areas, like the Potential Wilderness Areas, are allocated to different sets of management prescription areas in various alternatives. The Inventoried Roadless Areas (IRAs) recommended for wilderness study are discussed in the above section on Potential Wilderness Areas.

Alternative A was developed to reflect the continuation of the management direction of the 1993 Plan, which was developed before the 2001 RACR and hence, does not have direction that requires that all inventoried roadless areas retain their roadless characteristics. However, the management prescribed for the areas that are in the IRAs accomplishes nearly the same result. Ninety-five percent of the roadless areas are classified as unsuitable for timber production. There are very limited provisions for the harvest of dead or dying trees along the perimeters of some of these areas. In the 1993 George Washington Plan, road construction is prohibited on 88 percent of the areas with some exceptions to provide for site-specific needs. Examples of these exceptions where new road construction could be allowed include: 1) to access approved mineral activities; (2) where the new road is the only prudent alternative to serve resource needs in adjacent management areas and it will minimally impact this management area; (3) to relocate existing roads; (4) to provide access to trailheads or (5) to provide access to private land if no other route is feasible.

In Alternative C, all of the Inventoried Roadless Areas are Recommended for Wilderness Study and therefore the roadless qualities will be protected.

In Alternatives F, G, H and I all of the Inventoried Roadless Areas that are not Recommended for Wilderness Study have direction to maintain their roadless character and they will be managed consistent with the requirements of the 2001 RACR. For the recommended National Scenic Areas (NSAs), direction is dependent upon the authorizing legislation, but any IRAs within the NSAs will be managed consistent with the requirements of the 2001 RACR.

In Alternatives B, D and E, most of the Inventoried Roadless Areas that are not Recommended for Wilderness Study have the same direction as described for Alternatives F, G, H and I. However, in a few of the areas (nine in Alternative B, six in Alternative D and two in Alternative E) active management (including road construction and timber harvest, which are activities that would not be consistent with the 2001 RACR) would be allowed where active management has occurred along existing roads regularly over the past forty years. These areas are identified in Table 3C4-11. All other areas of Inventoried Roadless Areas would have management direction to maintain their roadless character and would be consistent with the 2001 RACR. In addition, Alternatives B and D allow salvage harvest (which would be an activity that would not be consistent with the 2001 RACR) from existing roads with no new road construction in any of the Inventoried Roadless Areas. Given the past experience with gypsy moth and expectation of continued mortality from this and other invasive pests, this would allow for the removal of dead trees with relatively little impact on the remote character of the Inventoried Roadless Areas.

Table 3C4-11. Portions of Inventoried Roadless Areas without Plan Direction to Maintain Roadless Character

Inventoried Roadless Area	Total Acres	Portions of Area Without Plan Direction to Maintain Roadless Character (Acres)						
		Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Crawford Mountain	9,852	N/A	1,200		1,400			
Dolly Ann	7,866	N/A	800		600			
Dry River (WV)	7,254	N/A	500					
Elliott Knob	9,391	N/A	200					
Jerkemtight	16,849	N/A	800		800			
Little Alleghany	10,207	N/A	700		1,000	1,000		
Little River	27,180	N/A	1000					
Mill Mountain/Rich Hole Addition	10,919	N/A	1,500		1,500	1,500		
Oak Knob	10,852	N/A	800		1,200			

In Alternative D the following Inventoried Roadless Areas are not identified as unsuitable for wind development: Little Alleghany, Oliver Mountain, Elliott Knob, Crawford Knob, and Northern Massanutten. A proposal for wind energy development in these areas could be accepted for analysis. If approved, wind turbines, associated transmission lines and access roads could be constructed. This would be outside of the management restrictions for IRAs, and if road construction or timber harvest is needed for wind energy development, it would be an activity that is not be consistent with the 2001 RACR.

Based on the above discussion, Alternative C provides the most protection for Inventoried Roadless Areas, followed by Alternatives F, G, H and I. Alternatives B and D provide the least overall protection for Inventoried Roadless Areas.

NOTE: Management activities in Inventoried Roadless Areas are conditional on the 2001 Roadless Area Conservation Rule. During the development of the issues and alternatives in this EIS, the 2001 RACR was under litigation and subject to changes in policy. Currently the 2001 RACR is in effect and applies to all IRAs. While Forest Plan management direction would allow timber harvest and road construction in some IRAs under Alternatives A, B, D and E, the 2001 RACR would not allow such activities to be implemented. Forest Plan direction under Alternatives C, F, G, H and I would be the same as the 2001 RACR for all of the IRAs.

C5 - SCENERY

AFFECTED ENVIRONMENT

The majority of the George Washington National Forest can be seen from adjacent or interior roads, trails or waterways largely due to the mountainous terrain and the supply of roads and trails. The more scenic landscapes (those inventoried as High or Moderate under the Scenery Management System (SMS)) are generally associated with or occur adjacent to high use roads, the Appalachian National Scenic Trail, National Recreation Trails, high use trails, lakes, rivers and streams, state and Forest Service designated scenic byways, and highly developed recreation areas.

The George Washington National Forest is located within Central Appalachian Broadleaf-Coniferous Forest Meadow Province and within the Valley and Ridge, Northern Blue Ridge and Appalachian Plateau sections as described by Bailey and others (1994). The landscape is about 80% mature forests with closed canopy. Elevations in the GWNF range from high points over 4,000 feet to lower elevations of less than 1,000 feet along some rivers and streams. Views beyond the immediate foreground are influenced by the viewer's elevation, terrain surrounding the viewer, as well as vegetation type and density. The steep to rolling ridges and valleys characterizing the forest are covered with an almost-continuous canopy of soft- to medium-textured rounded tree forms, creating a natural-appearing landscape character. The exception to this is the cultural landscapes, such as developed recreation areas, lakes and ponds, historic furnaces, pastoral areas, and administrative sites. These are typically found at lower elevations, often along rivers or streams and always along roads.

Over the last two decades, gypsy moth and southern pine beetle infestations have contributed to or caused tree mortality in some oak and pine stands resulting in visible patches of dead trees and scattered openings in the forest canopy. Groups of tall, gray, defoliated stems, varying in size from less than an acre to more than 25 acres, eventually give way to an emerging deciduous and evergreen understory. This process is speeded by active salvage operations in areas where human health and safety is critical. Hemlock woolly adelgid have caused mortality to individual trees as well as patches of hemlock, primarily in drainages and other cool, moist sites.

Of the seven Land Use Themes described in the Southern Appalachian Assessment, the existing GWNF landscapes can be grouped predominantly into four: Natural Evolving, Natural Appearing, Rural-Forested and Rural–Pastoral/Agricultural.

- Designated Wildernesses (42,674 acres) are lands where ecological processes predominate and are characteristically Natural Evolving landscapes.
- The vast majority of the Forest (about 1,000,000 acres) is characterized as Natural Appearing.
- Rural-Forested is a very small category that includes the Forest's most highly developed recreation areas.
- Rural-Pastoral/Agricultural is an equally limited category composed of open areas, often under special use permit for grazing, hay production or to perpetuate a pastoral scene.

Historically, the landscape character of Natural Evolving that dominated lands that now comprise the George Washington National Forest included open woodlands and grasslands/brushlands. These components of the landscape character declined dramatically since the turn of the previous century, mainly due to fire suppression. Characterized by an open mature tree canopy and a stable understory of native grasses, forbs and shrubs, open woodlands generally retained a natural, forested appearance interspersed with a mosaic of natural openings. The landscape featured structurally diverse forest communities, ranging from rich cove and mesic hardwood/pine forests, with predominantly closed canopies, to xeric pine/hardwood open woodlands, with a mosaic of grass/forb/shrub understories. A mid- to late-successional forest dominated the landscape. That historic, naturally evolving landscape contained both visual diversity and harmony. Alternatives B, C, E, F, G, H and I provide for acres allocated to mosaic of wildlife habitats including the restoration (to varying

degrees) of the historic role of fire in the ecosystem (and on scenery in terms of influencing landscape character).

Existing Visual Quality

The scenic resource management direction in the 1993 Forest Plan was the Visual Quality Objectives (VQO), which were determined by the Visual Management System (VMS). The scenic resource inventory has been updated to comply with the Scenery Management System (SMS), which replaced the VMS in 1995. Under SMS, Forest Plans establish Scenic Integrity Objectives (SIOs).[1] Table 3C5-1 provides a crosswalk between VQOs used in the 1993 George Washington Forest Plan, and SIOs in the Revised Forest Plan.

Table 3C5-1. Crosswalk Between VQOs and SIOs

Visual Quality Objective (VQO)	Scenic Integrity Objective (SIO)
Preservation (P)	Very High (VH)
Retention (R)	High (H)
Partial Retention (PR)	Moderate (M)
Modification (M)	Low (L)
Maximum Modification (MM)	Very Low (VL)

For planning purposes, Scenic Integrity Objectives (SIOs) were established for each management prescription area. These range from Very High (VH, unaltered) to Low (L, moderately altered). The SIOs define the different levels of alteration affecting the visual resource that is acceptable.

Table 3C5-2. SMS Inventory

Scenic Integrity Objectives	Acres	% of GWNF Land
Very High	46,000	4%
High	379,000	36%
Moderate	548,000	52%
Low	88,000	8%
Very Low	0	0%

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The scenic resource is affected by management activities altering the appearance of what is seen in the landscape. Short-term scenic effects are usually considered in terms of degree of visual contrast with existing or adjacent conditions that result from management activity. The scenic landscape can be changed over the long-term or cumulatively by the alteration of the visual character. Management activities, which result in visual alterations inconsistent with the assigned SIO and landscape character goal, even with mitigation, affect scenery. Management activities that have the greatest potential for affecting scenery are road construction,

[1] See *Landscape Aesthetics, A Handbook for Scenery Management, Agricultural Handbook Number 701* for description of the SMS system and cross-walk between the SMS-SIOs and the VMS-VQOs. The SMS inventory of George Washington National Forest lands identify Scenic Classes from 1 (highest level) to 7 within each prescription area. Each Scenic Class is assigned a Scenic Integrity Objective of Very High, High, Moderate or Low.

timber production, insect and disease control, special use utility rights-of-way, and mineral extraction. Other management activities that also can affect the scenic resource at a lesser degree are habitat management, prescribed burning, fire suppression, land exchange, old growth forest management, recreation, administrative site facility construction, and wildlife management. Natural processes can also affect scenery, such as wildfires, insect and disease infestations, and the spread of non-native invasive vegetation.

In all alternatives, the following prescription areas are assigned a Scenic Integrity Objective (SIO) of Very High across all scenic classes: designated Wilderness and Little Laurel Run Research Natural Area. In Alternative A, Recommended Wilderness Study Areas are also assigned a SIO of Very High.

In all alternatives, the following prescription areas are assigned a SIO of High across all scenic classes: Appalachian National Scenic Trail Corridor, Eligible Wild and Scenic Rivers (scenic classification), Geologic Areas, Riparian Corridors and Remote Backcountry. In Alternatives B through I, Recommended Wilderness Study Areas are assigned a SIO of High across all scenic classes.

In Alternative A, the following prescription areas are assigned a SIO of Low across all scenic classes: Administrative Sites, Communication Sites and Utility Corridors. In Alternatives B through I, there are no prescription areas assigned a SIO of Low across all scenic classes.

Table 3C5-3 below provides the distribution of SIOs across all alternatives.

Table 3C5-3. Scenic Integrity Objectives (SIOs) by Alternative (Acres)

SIO	Alt A*	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
VH – Very High	46,000	45,028	44,972	44,972	44,972	44,970	44,971	44,963
H – High	379,000	374,408	594,472	379,210	450,269	499,890	432,963	424,322
M - Moderate	548,000	199,216	237,678	196,132	178,843	160,927	182,157	579,573
L - Low	88,000	446,776	188,343	445,151	391,381	359,676	405,374	16,722

*No Action Alternative

Alternatives that receive the most acres assigned SIOs of Very High and High would result in more protection of the scenic resources than alternatives having fewer acres assigned to the higher SIOs.

The difference between alternatives with regards to acres assigned to the Very High SIO is negligible.

Alternative C assigns the most acres to the High SIO since the majority of those acres (386,786) are in the Recommended Wilderness Study prescription. For those acres that Congress designates Wilderness, the SIO would change to Very High. Alternative C provides the best protection of the current scenic integrity with primarily intact forest canopies. Alternatives F, E, G, H and I, in that order, assign the next most acres to the High SIO. Of those, Alternative F has the most acres allocated to the Recommended Wilderness Study prescription that would change to Very High if designated by Congress. Alternatives C and F have the potential to result in the most acres of the national forest being managed with a SIO of Very High.

Alternatives H and I assign the most acres to the Moderate SIO, followed by Alternatives A, B, C and D. The acreage in Alternatives H and I was designed to mimic the emphasis on scenic resources in the 1993 Forest Plan and resulted from increasing the Scenic Integrity Objectives in the Mosaics of Habitat Management Prescription Area from Low to Moderate in Scenic Classes 3, 4 and 5.

Alternatives B, D and G assign the most acres to the Low SIO and provide the least protection for the current scenic integrity of primarily intact forest canopies. Alternatives A, H and I have the fewest acres in the Low category due to the emphasis on protecting resources in the 1993 Forest Plan and carrying that emphasis forward in the preferred alternative. While Alternative C has more acres assigned to a Low SIO, its low level of management activities will result in the best protection of the current scenic integrity.

All alternatives propose prescribed burning, as detailed in Table 3C5-4 below. Drifting smoke, blackened rock outcrops and charred tree trunks would be the main negative visual effect. Visual contrast from fireline

construction could also be evident in the short-term. The contrast levels and duration vary with fire intensity. Blackened vegetation usually lasts a short time but charring of trees may be evident for years. Repetitive burning often results in loss of valued mid- and understory species such as flowering dogwood, but tends to promote herbaceous flowering species. Stands with open understories allow views farther into the landscape, sometimes to adjacent forest stands, a valley or meadow below, or to the next ridge.

Table 3C5-4. Planned Prescribed Burning Program by Alternative, acres per year

Activity	Alt A	Alt A¹	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Prescribed Burns, acres per year	3,000	7,400	12,000 - 20,000	0	5,000 - 12,000	20,000	12,000 - 20,000	12,000-20,000

Alt¹ represents the actual implementation level of the 1993 Forest Plan

Alternative E has the most acres in the prescribed burning program, and therefore the greatest potential for altered scenery, while Alternative C has the least.

Alternatives B, E, F, G, H and I contain management prescription area 13-Mosaics of Habitat that includes a landscape character goal of restoring the historic role of fire in the ecosystem, including the influence it had on landscape scenery. This landscape was characterized by a mosaic of closed canopy, open woodlands and grasslands/brushlands. Fire suppression has contributed to a transition in the landscape character to a predominantly closed canopy forest. This intact forest with little disturbance is the valued scenery today. The 1993 Forest Plan emphasized protecting this scenery by mitigating the appearance of canopy disturbing management activities. The reintroduction of fire into the ecosystem included in Alternatives B, E, F, G, H and I represents a potentially significant change in scenery to lands allocated to management prescription area 13. This prescription emphasizes, among other projects, restoring those open woodlands and grasslands/shrublands that existed as part of the natural evolving landscape. This restoration is expected to benefit many species of wildlife, grass forbs, and understory and mid-story species, including many flowering shrubs and edge-loving trees.

Prescribed fires mimicking the role of historic natural wildfires under Alternatives B, E, F, G, H and I would include more acres than under Alternatives A and D. These fires, some several thousand acres in size, would result in blackened and charred trees, including large patches of dead trees that will create openings in the canopy. With time, these openings will become natural appearing and add diversity to both the visual and biologic resources. These benefits are expected to make the transition from predominantly closed canopy to a mosaic that includes open woodlands and grasslands/brushlands an acceptable and valued landscape character.

Middleground is usually the predominant distance zone at which the national forest landscapes are seen. As stated previously, the George Washington National Forest is predominantly close canopied and evenly textured on the ridges and sideslopes, so the period of transition to the desired historic landscape character disturbed by fire will have a greater social effect when viewed in the middleground than in the foreground. This effect can be reduced by assuring that the target landscape character remains within the historic range; and, to the extent possible, attempt to design the openings to follow contours and be screened from critical viewing platforms by intervening vegetation and/or landforms.

In the long-term, added diversity of open woodlands and grasslands/shrublands intermixed with the closed canopy forests will enhance landscapes viewed in the foreground. The “green tunnel” on trails and roads will be interspersed with openings affording views to wildflowers, flowering shrubs and trees, landforms and rock outcrops, and increase opportunities to view wildlife within these areas. Opportunities exist to further enhance foreground views by creating vistas to scenic features.

Insect infections and diseases can cause strong, unattractive contrasts in the landscape. Management efforts to control insect infestations and diseases can minimize or reduce effects. Forest Service managers have the least flexibility to treat or control insects and disease infestations in Alternative C if Recommended Wildernesses are designated by Congress as Wilderness. Alternatives D, E, F, G, H and I provide the least potential effects to scenery due to insect and disease outbreaks. Under these alternatives, non-native and invasive species (NNIS) are treated aggressively, prevention and control in disturbed and/or high use areas is

emphasized, Integrated Pest Management (IPM) techniques are used, and a priority is placed on preventing spread to adjacent private lands. Alternatives A and B have less potential impacts than Alternative C but more than Alternatives D, E, F, G, H and I. Alternative A focuses primarily on controlling gypsy moth and Alternative B increases recognition of non-native and invasive species. Both Alternatives A and B make use of IPM techniques.

Utility rights-of-way (ROW) have a high potential of affecting the scenic resource for a long duration. Cleared ROWs and utility structures contrast and may be incongruent with existing landscape. Cleared ROWs contrast in form, line, color, and texture when compared to the natural appearing landscape.

Industrial wind development can have significant impacts on the scenic resource. Wind turbines hundreds of feet in length are erected on large concrete pads on ridgetops, visually breaking into the skyline when viewed from any angle except perhaps from an airplane. Roads are needed to access each wind turbine site, altering the form, line, color and texture of the natural landscape. Alternatives C and E would provide the most protection to the scenic resources, as they do not allow for any wind development. Alternative D has the potential for the most impacts to scenery, as it makes the entire forest available for proposals for wind development. Alternatives B, F, G, H and I restrict wind development in the most visually, socially and environmentally sensitive areas, but do not protect all areas from the potential impacts of wind development on scenery. Alternative A is silent on wind development.

Mineral management and development activities can involve a range of alterations from small surface structures along existing roads to major landform alteration, as well as form, line, color, and texture contrasts, causing substantially adverse scenic impacts. Alternative C has the least potential for negative impacts due to oil and gas leasing, as it does not allow any acres for this use. Alternative A has the potential for the most impacts due to oil and gas leasing, making 960,000 acres (90% of the Forest) available for standard or controlled surface occupancy. It contains no direction related to the development of Marcellus shale. Alternative D makes available 720,000 acres and Alternative B makes available 700,000 acres for leasing under standard or controlled surface occupancy stipulations. Both allow for the development of Marcellus shale, but specific standards would be used related to hydraulic fracturing.

Road maintenance, especially rights-of-way maintenance, affects scenery. Mowing frequency and timing alters the appearance of the landscape. Road construction introduces unnatural visual elements into the landscape and causes form, line, color, and texture contrasts. Road management controls how much of the landscape is seen by having roads open or closed.

Table 3C5-5. Average Miles of Road Construction per Year by Alternative

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Road Construction, miles per year	2.9	1.8	1.5	0	4.1	0.9	0.5	1.5

Alt[1] represents the actual implementation level of the 1993 Forest Plan

Related to roads, Alternatives C and F would have the least impacts to the scenic resource while Alternatives A and D would have the greatest potential for impacting scenery. Additionally, Alternative C would decommission 28 miles of road per year in the first decade of the Revised Forest Plan and Alternative F would decommission 18 miles. Alternative A does not provide for decommissioning of roads.

Vegetation management has great potential to alter the landscape and impact the scenic resource. Timber harvest practices can cause long-term effects on scenery by altering landscape character through species conversion, reduction in species diversity, manipulation of the prominent age class, and alteration of opening sizes, locations, and frequencies. The potential effects may be positive or negative, depending on their consistency with the desired future condition of the landscape.

Table 3C5-6. Estimated Harvest Acres and Allowable Sale Quantity for Timber Management Activities by Alternative, First Decade

Activity	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Acres regeneration harvest, in thousands, first decade	24	7	30	0	42.5	18	10	30	30
Allowable Sale Quantity, in million cubic feet, first decade	47	47	55.3	0	105.8	31.1	19.1	55.2	55.3

Alt[1] represents the actual implementation level of the 1993 Forest Plan

Related to timber production, Alternative C would have the least adverse effect on the scenic resource and Alternative D would have the greatest potential for adverse effects to scenery. Of the alternatives that provide for an active timber program, Alternative F would have the least effect on the scenic resources of the Forest.

Of the management applications, even-aged management may be the most impacting. Among the even-aged regeneration methods, clearcutting and seed-tree harvest produces the highest visual contrasts because they remove the most forest canopy and create openings with visible roads and/or skid trails. These openings would vary in their effects on scenery depending on location, size, shape and distance from viewing platforms. Openings that repeat the size and general character of surrounding natural openings, with the least contrast in line, texture and shape, would impact scenery the least.

Single-tree selection and group selection harvest are normally less evident because they do not cause large openings in the canopy. Uneven-aged regeneration methods can affect scenery, causing contrasts in form, line, color, and texture from slash production. All impacts as a result of timber harvest are short-term because of rapid vegetation growth.

Site preparation activities can affect scenery by exposing soil and killing other vegetation. These effects are generally short-term. Site preparation usually improves the appearance of the harvest area by removing the unmerchantable trees and most of the broken stems. Stand improvement work can affect scenery by browning the vegetation, reducing visual variety through elimination of target species. Table 3C5-6 provides the allowable sale quantity (ASQ) and annual harvest program by alternative.

In Chapter 3 of the Revised Forest Plan, Table 3-3 is a Scenery Treatment Guide which offers a list of measures to be considered for mitigating scenery impacts from management activities.

Recreation facilities are deviations to the natural landscape. None of the alternatives provide for the development of new developed recreation sites. Alternatives B, F, G, H and I provide for expanding the capacity of some existing recreation sites. Forest Service recreation facilities are designed to blend into the landscape without major visual disruption. Alternatives C and E would result in closing and decommissioning some recreation areas. All man-made elements would be removed and the site put back to grade. Vegetation would eventually grow in and the casual observer would not be able to tell that a developed area had once existed there.

Designation of wilderness will generally cause positive effects to the scenery. Barring serious infestations by insects or disease, old growth forest character will be created over time. What it lacks in visual variety, it makes up for with an intact, natural appearing landscape. Alternative C provides for the most recommended Wilderness at about 22% of the George Washington land base. Alternative F is next highest for recommended Wilderness acres, at about 9% of the Forest. Alternatives A, B and G provide for the least acres being allocated to recommended wilderness study areas.

Areas recommended for national scenic area designation are managed to assure protection of the area's scenic qualities. Alternatives with lands allocated to this management prescription area, in order of acres allocated, are Alternatives F, H, I and D. All alternatives contain the existing Mount Pleasant National Scenic Area.

In summary for scenery, the most significant potential adverse effects would come from (in order):

- industrial wind energy development (highly visible ridgetop development),
- road construction associated with special uses and timber production (canopy opening, line/color/texture contrast of the roads),
- minerals development and extraction (vegetative clearing, structures, previously mentioned roads),
- prescribed burning associated with restoration of fire dependent ecosystem (large canopy openings, charred trees and rock outcrops), and
- timber production (canopy openings, slash, previously mentioned roads)

The alternatives in order that provide the most protection of current scenic conditions and integrity are C, E, A, F, H, I, G, B, D. The alternatives that would restore, in part, the historic naturally evolving landscape character are B, E, F, G, H and I. This would result in a transition to a landscape character appearance that is within the historic range of variability.

C6 - TIMBER MANAGEMENT

AFFECTED ENVIRONMENT

Forested Area

The GWNF includes approximately 1,066,000 acres of National Forest System land in Virginia and West Virginia. Of this, approximately 1,058,000 acres are known to be forested. As indicated in Table 3C6-1, the majority of the land area within each county is forested with a considerable variance in the percentage of national forest land located within each county.

Table 3C6-1. Percentage of Forested Land and GWNF Land by County

County	% Forested	% GWNF
Alleghany, VA	60%	49%
Amherst, VA	76%	19%
Augusta, VA	52%	30%
Bath, VA	94%	51%
Botetourt, VA	66%	4%
Frederick, VA	61%	2%
Hampshire, WV	77%	1%
Hardy, WV	82%	14%
Highland, VA	82%	22%
Monroe, WV	57%	<1%
Nelson, VA	84%	7%
Page, VA	47%	13%
Pendleton, WV	75%	11%
Rockbridge, VA	68%	12%
Rockingham, VA	58%	25%
Shenandoah, VA	51%	23%
Warren, VA	55%	5%

Forest Land Tentatively Suitable for Timber Production

During forest land and resource management planning, the Forest Service is required to identify lands unsuited for timber production (16 USC 1604(k); 36 CFR 219.14). The initial stage (Stage I) identifies land tentatively suitable for timber production. Refer to Appendix B for detailed explanation of the three stages of land suitability determination. Table 3C6-2 displays lands eliminated in Stage I suitability analysis to determine acres tentatively suitable for timber production.

Table 3C6-2. Stage I Acres Tentatively Suitable for Timber Production

Category of Stage I Lands	Acres
Total GWNF Acres	1,065,000
Non-Forest Land	(7,000)
Forest Land	1,058,000
Withdrawn for Existing Wilderness	(43,000)
Withdrawn for Existing National Scenic Area	(8,000)
Withdrawn for Research Natural Areas	(2,000)
Irreversible Damage & Not Restockable	(29,000)
Incapable of Producing Industrial Wood	(65,000)
Stage I Tentatively Suitable for Timber Production	911,000
Stage I Not Suitable for Timber Production	154,000

Age Class Distribution

Most of the timber on the GWNF is currently in the 90-130 year old age class as evidenced by Table 3C6-3 showing current age class distribution. A majority of the Forest is either at or beyond currently specified rotation ages. Meanwhile, the very small amounts of acres (1-3%) in the younger age classes result from the lower levels of management in the past on this Forest. The age class imbalance is dramatic and is indicative of non-regulated forest management.

Table 3C6-3. Percentage of Forest by Age Class on the GWNF Base Year 2010.

Age Class	Percent
1-10	1%
11-20	3%
21-30	2%
31-40	4%
41-50	1%
51-60	0%
61-70	1%
71-80	5%
81-90	13%
91-100	22%
101-110	18%
111-120	8%
121-130	7%
131-140	5%
141-150	4%
151+	6%
Total	100%

Community Types

As the forest ages, it will experience increasing insect and disease problems. Gypsy moth populations will continue to exhibit periodic outbreaks in an unpredictable fashion (Elkinton and Liebhold 1990). Varying amounts of mortality are expected in the two oak-associated community types which dominate the GWNF; Northeastern Interior Dry-Mesic Oak Forest and Central and Southern Appalachian Montane Oak Forest. These community types comprise 36% and 41%, of the total forested acreage, respectively. With these oak-associated community types comprising about 77% of the total forested acreage, substantial periodic gypsy moth defoliations and oak decline events resulting in subsequent mortality is anticipated (Gansner and Herrick 1984). No community type conversions were modeled in the plan. No reliable methodology is currently available to quantify the specific extent of future natural type conversions due to natural forest succession and/or gypsy moth/oak decline mortality.

Salvage operations will be continuing as we attempt to salvage the dying trees prior to the oak losing their capability to stump sprout and regenerate the next stand to a desirable oak component to meet desired conditions.

Forest Service Historic Importance

The Southern Appalachian Assessment (SAA 1996) indicates that the USDA Forest Service is the area's largest single landholder. Thus, the action of the region's national forests can hold more sway over markets than those of any other single landowner. The supply behavior of the public sector is, however, exceedingly difficult to predict. Timber supply from the national forests is governed by laws, agency policy and regulations and a management approach that addresses multiple uses as well as ecological conditions (SAA 1996 Rpt 4:113).

The Southern Appalachian Assessment (SAA) indicates that the pattern of timber production from the national forests has changed considerably. Between 1977 and 1994, the national forests in the SAA averaged 36.6 Million Cubic Feet (MMCF) or 183 million board feet per year. For the years 1983, 1986, 1989, and 1992, the national forests provided between 10-12 percent of total production in the SAA. Since national forests have 17 percent of the timberland, their share of total production reflects a less intensive management approach than on private land (SAA 1996 Rpt 4:122).

Timber production on the GWNF has experienced a decline which has continued since 1993 to the present. The following Table 3C6-4 displays total sold volume in Hundred Cubic Feet (CCF) and Thousand Board Feet (MBF) on the GWNF from the first year of plan implementation (1993) through FY 2011. The most recent 3 year average volume sold (2009-2011) reflects an almost 300% drop as compared to the 3 year average of 1993-1995. Historically about 30% of the volume sold is sawtimber, 50% is roundwood (pulpwood), and 20% is fuelwood. Of the fuelwood category, a large majority is personal use firewood permits while a small percentage is offered through a conventional commercial timber sale.

Table 3C6-4. Total Timber Volume Sold

FY	CCF	MBF
1993	68,118	34,059
1994	58,550	29,275
1995	52,122	26,061
1996	41,074	20,537
1997	38,436	19,218
1998	16,876	8,438
1999	30,086	15,043
2000	20,202	10,101
2001	24,886	12,443
2002	26,994	13,497
2003	24,210	12,105
2004	36,814	18,407
2005	23,550	11,775
2006	22,047	11,023
2007	16,362	8,181
2008	22,416	11,208
2009	16,403	8,201
2010	24,280	12,140
2011	23,598	11,799

During the period from 1993-2011, the harvest cutting methods by acres displayed in Table 3C6-5 were utilized to implement the timber management program objectives from the first year of plan implementation. There has been a relatively steady decline in total acres harvested on the GWNF since 1993. A steady decline in the total acres harvested by clearcutting has occurred from 1993 to 2005 with a slight increase in more recent years. Clearcutting acres have averaged less than five percent of total annual harvested acres for the last ten years.

Table 3C6-5. Acres by Harvest Cutting Method for Harvested Volume by Fiscal Year

FY	Clearcut	Shelterwood	Selection	Thinning	Salvage	Special	TOTAL
1993	890	938	644	212	587	0	3,271
1994	496	1,121	251	259	866	0	2,993
1995	277	1,281	55	262	832	0	2,707
1996	232	875	0	172	685	0	1,964
1997	209	1,103	0	64	1,839	0	3,215
1998	133	739	0	82	495	0	1,449
1999	41	436	1	92	714	0	1,284
2000	90	428	173	125	438	0	1,254
2001	67	668	97	244	86	0	1,162
2002	5	646	48	133	49	0	881
2003	0	579	57	49	104	0	789
2004	0	625	0	111	44	0	780
2005	0	962	29	104	81	0	1,176
2006	25	459	36	247	50	7	824
2007	22	364	6	340	0	0	732
2008	9	556	0	46	0	0	611
2009	70	344	0	345	74	0	833
2010	97	371	0	67	71	0	606
2011	10	498	0	143	0	0	651
10 Yr. Av.	24	540	18	159	47	1	788
5 Yr. Av.	42	427	1	188	29	0	687
3 Yr. Av.	59	404	0	185	48	0	697

Forest Service Timber Inventory

Information regarding the supply of timber was compiled using the most recent available Forest Inventory and Analysis (FIA) data. Of the 19.2 million acres in the wood product market area for the George Washington National Forest, 12.5 million acres are inventoried as timberland. Figure 3C6-1 provides the percentage of area of timberland within broad ownership classes. The two largest categories include privately held and National Forest Service (NFS) lands (including the entire George Washington National Forest and portions of the Jefferson and Monongahela National Forests) accounting for 96% of the timberland in this market area. The George Washington National Forest comprises approximately 5.5% of the land within the market area.

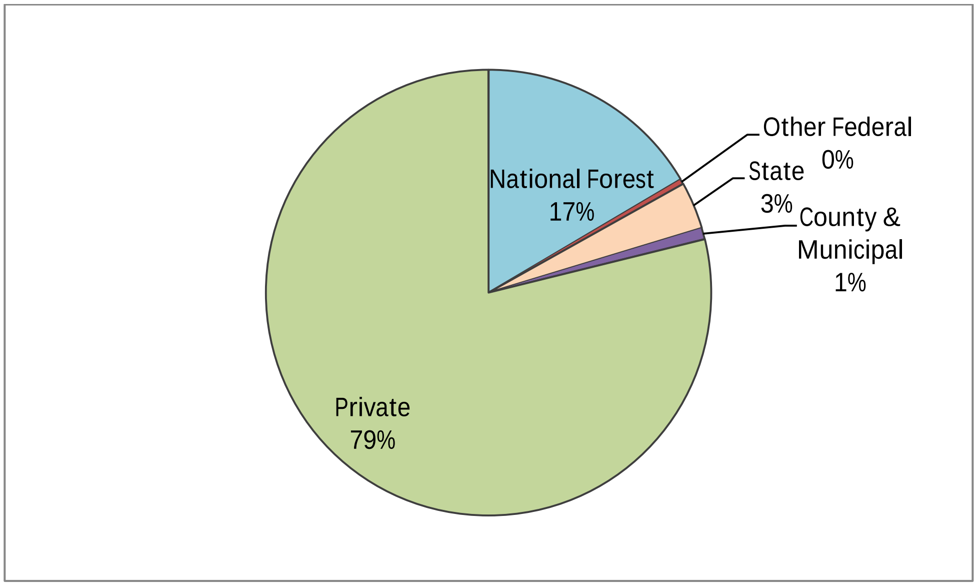

Figure 3C6-1. Percent Ownership of Timberland in the GWNF Market Area

We estimate 7-8 BCF (Billion Cubic Feet) of timber supply on economically available timberland in the market area and considering landowner attitudes (after Worthington et al. 1996). We can expect this to grow by about 0.57 BCF per year. Annual demand is about 0.3 BCF per year; less than the net growth of all live timber, indicating a sustainable resource.

Approximately 2 BCF of live standing volume within the market area is found on the GWNF. Of this total live volume, 1.8 BCF, or 86%, of this volume is in large diameter stands (>19 inches average DBH). Similarly, about 1.9 BCF, or 90%, of this volume is greater than 60 years old. Thus, a vast majority of the standing timber on the GWNF is of sawtimber size and mature trees. However, of the 2 BCF in live standing volume on the GWNF, we estimate only 0.51 BCF of that would be available on the GWNF after considering economic availability and current lands unsuitable for timber production.

Biomass fuels for the generation of energy, referred to here as wood biomass energy, are gaining interest and support in many parts of the south. The potential to supply wood biomass energy from the GWNF is included in the aforementioned estimates. Of the 0.51 BCF available as supply, anywhere from 0 to 0.25BCF (250 MMBF) could potentially be utilized as wood biomass energy, or a maximum of 8.75 million tons forest-wide. The upper bound of this estimate is the small roundwood component usually utilized in paper production plus the traditionally non-merchantable material in branches and tops; we presume that no sawtimber would be utilized as wood biomass energy. However, it is important to note that under current management the entire Forest only produces about 70,000 tons of wood, including sawtimber. This puts the almost 9 million ton figure identified as a maximum into perspective; it is probably not realistic.

The GWNF comprises a very small market share within this market area. We estimate that we control about 0.5 BCF of the total live volume available for supply. When we compare this to the 8 BCF estimated to be available in the entire market area, the GWNF comprises about 6% of the total live inventory. However, when we consider the variation in quality of supply and the demand for quality timber, the GWNF may have a slightly more significant role to play. Demand for high quality products is greater, we expect increased pressure on high quality timber, and the GWNF has a proportionally higher percentage of large diameter (equating to high quality) timber on NFS lands as compared to Non-Industrial Private Forest (NIPF) lands (albeit only slightly higher). So, while the primary producers of the timber industry within this market area do not depend on the timber from the GWNF to any large extent, the GWJ can play a more significant role in the supply of high quality sawtimber. In terms of wood biomass energy, the GWNF would likely comprise an even smaller share of the

market, if such a market were to develop. Typically, energy production mills that utilize wood in part or in whole require a million or more tons of fiber annually. Realistic estimates, under current management, indicate that the GWNF could produce perhaps 30,000 tons annually within any given 50 mile radius around a mill location.

Although the scope of this analysis is very broad, encompassing some 64 counties in three states, we believe it is also important to consider the role of NFS lands on a more local level. NFS lands occupy 30% or more of three of the counties in the market area and a few more counties contain 20-30% NFS lands. Certainly the role that the timber supply from NFS lands play in these local economies is quite important and should not be lost or discounted when taking a larger view.

DIRECT, INDIRECT EFFECTS AND CUMULATIVE EFFECTS

Suitability

As displayed in Table 3C6-2 above, approximately 86% (911,000 acres) of the Forest is “tentatively suitable” for timber production. Table 3C6-6 displays the acreage unsuitable for timber production and suitable for timber production for the nine alternatives considered. None of the alternatives used more than 46% of the lands tentatively suitable for timber production. Alternatives B and D contain the most lands suitable for timber production. Suitable acres vary from 0 to 499,000 acres.

Table 3C6-6. Determination of Lands Suitable for Timber Production from the Stage III Analysis

Alternative	Acres Unsuitable for Production	Acres Suitable for Production	Percent Suitable for Production
A	715,000	350,000	33%
B	566,000	499,000	47%
C	1,065,000	0	0%
D	570,000	495,000	46%
E	698,000	367,000	34%
F	784,000	281,000	26%
G	616,000	449,000	42%
H and I	613,000	452,000	42%

Allowable Sale Quantity

Table 3C6-7 displays the allowable sale quantity (ASQ) for all products in Million Cubic Feet (MMCF) and Million Board Feet (MMBF) for each alternative considered in detail in the FEIS. ASQ is the maximum amount of timber that can be sold on lands suitable for timber production during the first decade of implementing any alternative.

Standard Region 8 conversion of 5.0 board feet per cubic foot was used in Table 3C6-7 calculations to convert from cubic feet to board feet.

These alternatives have ASQs ranging from 0 to 105.8 MMCF per decade. As Table 3C6-7 indicates the alternatives explore a wide range of volume outputs to achieve a wide variety of desired conditions.

Table 3C6-7. Allowable Sale Quantity for all Products by Decade

Alternative	MMCF	MMBF
A*	47	235
B	55.8	279
C	0	0
D	105.8	529
E	31.1	155
F	19.1	96
G	55.2	276
H and I	55.3	276

*The volume shown for Alternative A (current Forest Plan) uses the same Regional conversion factor as the other alternatives, which is different from the conversion factor shown in the 1993 Forest Plan.

Table 3C6-8 displays ASQ for each alternative by decade. Table 3C6-9 displays Long-Term Sustained Yield Capacity, Inventory Volume, and estimated acres treated by alternative. The long-term sustained-yield capacity (LTSYC) is defined as "the highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple-use objectives (USDA Forest Service 1982 CFR 219.3)". LTSYC is the potential average growth (mean increment) of the forest on acres allocated to timber production after the stand has reached a managed stand structure. It can be thought of as a steady state timber output after the existing stands have been cut and each acre allocated to timber production has settled into a particular management intensity and rotation age. NFMA regulations require: "each sale schedule shall provide for a forest structure that will enable perpetual timber harvest which meets the principle of sustained yield and multiple-use objectives of the alternative (219.13(D))". The perpetual timber harvest constraint meets the NFMA requirement by ensuring that the forest contains as much timber inventory volume in the last period as a forest would have, on the average, under the management intensities selected in the analysis. All of the ASQs are well within current demand of 300 MMCF per year with reasonable likelihood of selling.

Table 3C6-8. Allowable Sale Quantity for All Products by Decade (MMCF)

Alternative	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
A*	47	47	47	47	47
B	55.8	61.3	65.2	65.7	65.7
C	0	0	0	0	0
D	105.8	105.8	105.8	105.8	105.8
E	31.1	34.2	37.6	38.4	38.4
F	19.1	20.9	23.1	23.1	23.1
G	55.2	57.6	58.4	59.2	59.2
H and I	55.3	60.7	60.7	63.5	65.4

*The volume shown for Alternative A (current Forest Plan) uses the same Regional conversion factor as the other alternatives, which is different from the conversion factor shown in the 1993 Forest Plan.

Table 3C6-9. Estimated Volume by Wood Product for First Decadal ASQ by Alternative, MMCF

Alternative	Hardwood Sawtimber	Softwood Sawtimber	Hardwood Pulpwood	Softwood Pulpwood	Total
A	13.1	0.1	33.8	0.1	47.1
B	17.6	3.0	29.3	5.9	55.8
C	0	0	0	0	0
D	60.5	4.9	36.1	4.3	105.8
E	8.8	1.3	17.6	3.4	31.1
F	5.2	0.9	10.0	3.0	19.1
G	18.3	2.4	29.2	5.3	55.2
H and I	19.5	2.9	27.6	5.3	55.3

Table 3C6-10. Long-Term Sustained Yield Capacity, Inventory Volume, Allowable Sale Quantity, and Acres Regenerated by Alternative

Unit of Measure	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
	MMCF/Year							
Long Term Sustained Yield Capacity	5.8	6.5	0	11.6	4.9	3.2	6.3	6.4
Inventory Volume, Decade 1	21.58	22.3	0	36.2	15.6	9.5	21.9	23.1
Allowable Sale Quantity	4.7	5.6	0	10.6	3.1	1.9	5.5	5.5
	Acres/Year							
Acres Regenerated	2,400	1,800 - 3,000	0	3,000 - 4,250	1,800 – 3,000	1,000 – 1,800	1,800 - 3,000	1,800 - 3,000

Timber Sale Program Quantity

The Timber Sale Program Quantity (TSPQ) is the volume of timber planned for sale during the first 10 years. It includes the volume harvested from the suitable land base plus planned volume from unsuitable lands. For this analysis no harvest was planned on unsuitable lands under any alternative. Therefore the ASQ discussed previously equates to the TSPQ. The preceding tables also constitute the sale schedule by alternative.

Net Present Revenues

The following Table 3C6-11 displays the average annual net present value in millions of dollars for the timber program using SPECTRUM costs and revenues. This table shows how the projected revenues of the timber program within each decade and each alternative compare to the costs of the timber program. The "net" value is how much average annual revenues exceed costs. For Alternative A, the Spectrum model solved for the objective function to maximize present net value. For Alternative D, Spectrum solved for the objective function to maximize volume. For Alternatives B, E, F, G, H and I, the model solved for the objective function to maximize early successional habitat. Since Alternative C does not have a timber program, there are no values shown. The variation within each alternative across the decades is reflective of the model choosing different combinations of harvest methods and wood product classes that vary in their costs and revenues.

Table 3C6-11. Average Annual Net Present Value in Millions of Dollars for the Timber Program

Alternative	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5
A	(7.22)	(4.88)	(3.30)	(2.23)	(1.50)
B	(7.36)	(1.0)	6.60	0.9	2.36
C	0	0	0	0	0
D	16.79	6.88	6.87	4.96	3.80
E	(8.15)	(2.95)	0.18	0.12	0.52
F	(7.84)	(4.24)	(1.08)	(0.96)	(0.61)
G	(7.09)	(1.75)	0.57	0.26	1.17
H and I	(5.94)	(0.08)	1.84	0.89	1.66

Demand

The process paper "George Washington National Forest Timber Supply and Demand Analysis" established The GWNF market area as generally being within a 50-mile radius around the Forest's boundary. Approximately 217 sawmills, 3 paper/pulp mills, and 3 engineered wood product manufacturers are located within the GWNF market area with a combined consumption of 300 MMCF of roundwood annually (Virginia Primary Forest Products Directory 2001; West Virginia Division of Forestry, Maryland Department of Natural Resources). Approximately 30% of this material is used for the production pulp and paper. The remainder is used in the manufacture of sawtimber or engineered products.

The ownership distribution of the "economically available" timber supply mirrors the general pattern of timberland ownership in the market area, with approximately 80 percent of the supply on NIPF land, 17 percent on the National Forest (8.5 percent on the GWNF), and the remainder in Other Federal, State, and County/Municipal lands. If the GWNF were to satisfy the current demand within the market area of 300 MMCF/year, in the same proportion as the economically available resource supply, the estimated annual demand for products from the George Washington National Forest would be 25.5 MMCF (300 MMCF times 0.085 = 25.5 MMCF/year).

Currently, the demand for wood biomass energy on the GWNF, other than traditional firewood, is negligible. There are 2 electrical cogeneration plants of any size within the market area; one located in Pittsylvania County and the other in Campbell County. Combined, these plants have the capacity to utilize approximately 1.25 million tons per year (personal communication, Jed Brown, Virginia Department of Environmental Quality). There is an indication that one of these plants will soon be taken off-line, reducing the potential capacity to about 1 million tons per year. Additionally, Mead-Westvaco has announced the conversion/construction of a large boiler capable of accepting wood biomass for energy. They are projected to use more than 500,000 tons annually in the near future. There are no plants that produce fuel pellets from raw wood products. We do not have the technology at this time to economically produce bio-fuels (e.g. ethanol) from wood, although those processes are being researched and perfected. While we foresee an increase in demand for wood biomass energy over the life of this analysis, it appears that any increase in the near future may be relatively small.

Supply and Demand Comparison

Table 3C6-12 displays the annual timber sale quantity as a percentage of the current demand. Demand from the forest is equal to 25.5 MMCF/year for the first 10 years of plan implementation.

Table 3C6-12. Supply (ASQ) as a Percent of Current Annual Demand from GWNF Lands

Alternative	MMCF	% of Demand
A	4.7	18
A[1]	2.2	9
B	5.6	22
C	0	0
D	10.6	41
E	3.1	12
F	1.9	7
G	5.5	22
H and I	5.5	22

Alt[1] represents the actual implementation level of the 1993 Forest Plan

As displayed in the table above, no alternative meets or exceeds current market demand. Alternatives meet between 0% and 41% of current demand for timber products that would come from GWNF lands.

When the market is segmented into high, average, and low quality categories, the current demand for the high value category is estimated to be about 0.9 MMCF per year of high quality hardwood sawtimber for the GWNF, if the forest were to satisfy current demand in the same proportion as the economically available resource supply. As indicated in Table 3C6-12 Alternative D would provide the highest level of high value sawtimber. Other alternatives provide considerably less in descending order from Alternative B, G, H and I, A, E, F, and C.

Presumably the supply/demand relationship as it relates to wood biomass energy under each alternative would roughly follow the same relationship displayed in Table 3C6-12 above. Since current demand is minor and we cannot reliably predict future demand, even approximate figures for each alternative cannot be computed. Further, it is worth stressing that the Forest Service does not control how the raw material is utilized, other than restrictions on woody biomass utilization. Alternatives A, C, and F would limit woody biomass utilization to a minimum of a 4" diameter, the same limit that currently applies to the standard commercial timber sale. These alternatives would have less potential to supply wood biomass energy as compared to Alternatives B, D, E, G, H, and I. However, all alternatives, except C, will supply some level of small roundwood. Whether this material is used to produce paper or wood biomass energy is solely related to local market conditions in the area at the time; the Agency does not control that aspect. This factor further contributes to the inability to estimate our supply or role in wood biomass energy markets in any meaningful way.

Age Class Distribution

Table 3C6-13 displays expected age class distribution in 2040, by alternative, following 30 years of plan implementation.

Table 3C6-13. Estimated Percentage of Forest by Age Class and Alternative on the GWNF Base Year 2040

Age Class	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
1-10	2	0	3	0	4	2	1	3	3
11-20	2	0	3	0	4	2	1	3	3
21-30	2	0	3	0	4	2	1	3	3
31-40	1	1	1	1	1	1	1	1	1
41-50	3	3	3	3	3	3	3	3	3
51-60	2	2	2	2	2	2	2	2	2
61-70	4	4	4	4	4	4	4	4	4
71-80	1	1	1	1	1	1	1	1	1
81-90	0	0	0	0	0	0	0	0	0
91-100	1	1	1	1	1	1	1	1	1
101-110	6	7	6	7	6	6	7	6	6
111-120	12	13	11	13	11	12	12	11	11
121-130	19	21	19	22	17	20	20	19	19
131-140	16	18	16	22	15	17	17	16	16
141-150	7	8	7	8	7	8	8	7	7
151+	20	20	20	20	20	20	20	20	20
Total	100	100	100	100	100	100	100	100	100

Alt[1] represents the actual implementation level of the 1993 Forest Plan

As Table 3C6-13 indicates in 30 years, the majority of the forested acres in each alternative will be in stands with a stand age greater than 100 years. Projected levels of timber harvesting to create early, sapling/pole, and mid seral stage habitats in any alternative will not offset this further "aging" of the Forest. Alternative C will have the highest percentage of stands 100 years and older with 92%. Alternatives B, E, F, G, H and I are grouped between 79 and 87%, and Alternative D is the lowest at 76%. Conversely, Alternative D will have the greatest percentage of habitats less than forty years of age with 13%. Alternatives B, G, H and I are grouped at about 10%. Alternatives A and E are 7% followed by Alternative F and C at 4 and 1%, respectively.

Methods of Harvest

Table 3C6-14 displays the method of timber harvest by alternative for the first 10 years of plan implementation.

As Table 3C6-14 displays, the seven alternatives explore the use of a wide range of timber harvesting methods to meet a variety of desired future conditions. Uneven-aged harvest methods have generally been limited to lands that have a manageable individual area of at least 100 acres, with slopes less than 30 percent, and within ½ miles of existing roads for physical and economic reasons. All alternatives employ various amounts of group selection, except for Alternative C which employs none. The greatest amount of clearcutting is employed in Alternative D, followed in decreasing amounts by Alternatives A, B, E, G, H and I, F, and C. All alternatives employ various mixes of shelterwood harvesting, and significant thinning is employed in Alternatives B, E, G, H and I.

Table 3C6-14. Acres by Method of Harvest for the First 10 Years for all Harvest Methods

Alternative	GS	CC	SWR	SW-2 Stage	Thin	Total
A	800	3,000	20,000	0	1,740	25,540
A[1]	0	600	4,500	0	1,900	7,000
B	500	900	21,300	7,300	4,000	34,000
C	0	0	0	0	0	0
D	500	8,500	6,900	26,600	2,000	44,500
E	500	900	14,600	2,000	4,000	22,000
F	500	500	4,500	4,500	2,000	12,000
G	500	900	21,300	7,300	4,000	34,000
H and I	500	900	22,300	6,300	4,000	34,000

Alt[1] represents the actual implementation level of the 1993 Forest Plan
GS = Uneven-aged Management using Group Selection. CC= Clearcut. All commercial trees are removed at initial regeneration harvest. SWR-Two aged shelterwood where 20-40 square feet of residual trees of commercial species 8-14 inch dbh are retained which may be removed at a later thinning of the new stand or at final rotation of the new stand. SW-2 Stage= True two step shelterwood. First entry leaves about 50 BA (1/2 of original stand) and occurs about 10-20 years before final harvest cut that completely removes overstory.

Table 3C6-15 displays the relative amount of even-aged, two-aged and uneven-aged silvicultural systems employed during the first 10 years of plan implementation by alternative.

Table 3C6-15. Percentage of Regeneration Acres for Even-Aged, Two-Aged, and Uneven-Aged Silvicultural Systems by Alternative in the First 10 Years

Alternative	Even-Aged	Two-Aged	Uneven-Aged
A	22%	71%	7%
B	27%	71%	2%
C	0	0	0
D	83%	16%	1%
E	16%	81%	3%
F	50%	45%	5%
G	27%	71%	2%
H and I	24%	74%	2%

C7 - MINERAL RESOURCES MANAGEMENT

AFFECTED ENVIRONMENT

The public use and enjoyment of the GWNF as well as the Forest's administration of renewable resources requires the use of, and creates demand for, a wide range of energy and non-energy mineral resources. The GWNF also contains mineral resources and is a potential source, or supply, for some mineral resources. For more information on the affected environment and environmental effects related to federal oil and gas leasing on the GWNF, see Section D of this Chapter.

Forest's Demand for Minerals

This million-acre Forest uses energy and non-energy mineral resources to accomplish Forest Plan goals and objectives for the wide range of resource programs. The overwhelming majority of the tools, equipment and energy used to manage the Forest and sustain ecosystems are made of minerals, not wood. Minerals are used in three forms, 1) the hardware made from minerals: tools, equipment, infrastructure, vehicles, etc. 2) highly processed mineral supplies needed to operate and maintain the hardware: gasoline, oil, chemicals, batteries, etc. 3) minerals used as construction materials or in a relatively raw form: aggregate, rip-rap, concrete, landscaping rock, crushed limestone for liming streams.

Every day personnel on the GWNF use the non-renewable resources of gasoline and diesel fuel. Based on Forest fleet records, the GWNF in 2012 used an estimated 78,000 gallons of fossil fuels (gasoline and diesel) traveling 1.1 million miles in 128 vehicles. Assuming comparable annual use over the past 20 years since the previous Forest Plan, the Forest fleet has used on the order of 1.5 million gallons of fossil fuel. This estimate does not include the many other uses of fossil fuel such as, 1) contractors performing road grading, road resurfacing, cutting up and hauling fallen trees that block roads and bridges, 2) volunteers travel back and forth to the Forest, such as indicated by the 43,000 hours contributed by volunteers to the dispersed recreation program in FY2011, 3) helicopters and fixed wing aircraft used in fire management, insects and disease surveillance and monitoring, and flood and wind storm damage assessments, 4) airplane, bus and vehicle transportation of fire fighters from across the U.S. to fight forest fires on the Forest. Considering these other uses as well as fleet use, the annual gasoline/diesel consumption for Forest administration is estimated to be on the order of 100,000 gallons.

Gasoline is also used by the recreating public in travel to the GWNF. The numbers of Forest visitors and distances travelled in FY2011 are reported in the Forest's Visitor Use Report as part of National Visitor Use Monitoring (FY2011 USDA-Forest Service). Data in the Report was used to make an estimate of total miles travelled and fuel consumption. Visitors travelled about 80 million miles in order to recreate on the Forest in FY2011. Assuming 20 miles per gallon, recreation use of the Forest consumed on the order of 4 million gallons of gasoline/diesel in FY2011. This estimate includes only round trip mileage from the visitor's home to the Forest, and does not include any additional miles the visitor may have travelled on the Forest as part of the visit.

The Forest uses mineral materials (crushed rock aggregate, rip rap, landscaping rock, etc.) to construct and maintain the roads, develop recreation sites, trailheads, and other facilities. The largest use of mineral materials is on the Forest's 1,823 miles of system roads. Traffic on the 1,000 miles of system roads that are open year-round or seasonally wears out the road surfacing aggregate. Traffic crushes and abrades the rock fragments, turning the rock to dust that washes off or blows off the roads. New aggregate must be added to the roads periodically to maintain the road. Every year the Forest resurfaces a few roads with several thousand tons of aggregate. But road surfacing as well as periodic road grading are the two most expensive items in maintaining roads, and so, there is a backlog of many miles of roads needing resurfacing.

In addition to regular maintenance, minerals materials in large quantities are need to repair the roads and stream crossings damaged or destroyed by storm events, floods, road slopes failures, etc. The Forest uses rocks pits on the Forest to supply some mineral materials. However, the vast majority of mineral materials used by the Forest are purchased from private rocks pits located off the Forest.

The GWNF, like other National Forests, depends on the U.S. maintaining and continuing the historic shift from use of wood to the use of minerals. In the 19th century, conservation pioneers were predicting the catastrophic loss of American forests since wood was among the most widespread and essential materials both for domestic use and industry (MacCleery 1992). The escalating trend to loss of forests was broken when the U.S. made an historic shift from the use of wood to the use of minerals. Several factors for this break in trend are discussed by MacCleery (1992), including the important role of mineral resources, such as: "During the first half of the 19th century, domestic output of forest products rose at the rate of population growth. Heating and cooking was the largest use of wood during this period, averaging from one-half to two-thirds of total wood use. In 1850 wood provided over 90 percent of the nation's energy. After 1900, fossil fuels largely replaced wood fuels, and wood substitutes, such as steel and concrete, replaced wood in some structural applications." MacCleery (1992) states, "By the 1920s, the three-hundred-year loss of Forest land in the United States had nearly halted. Today, the country has about the same area of forest as it did in 1920." As Sedjo (1990) notes, although the population had continued to increase, the total wood consumption in the U.S. declined after the first decade of the 20th century. The indispensable role of mineral resources in the historic restoration and sustainability of forests continues up to the present, and will be required in the future to restore and sustain forests (Collins et al. 1997).

Federal Leasable Minerals Management

Management of the federal leasable mineral resources is a shared responsibility between the U.S. Department of Interior and the USDA, Forest Service. The Bureau of Land Management (BLM) has a major role in issuing and supervising operations on licenses, permits, and leases for federal leasable minerals. The BLM cooperates with the Forest Service to ensure that impacts upon surface resources are mitigated and that the land affected is reclaimed. The Forest Service is also involved in the federal issuing of licenses, permits, and leases and in administering on-the-ground operations on NFS lands. Over the past decades, Congress has expanded the role of the Forest Service in the federal leasable minerals process.

The Forest Service will make a leasing availability decision only on federal oil and gas. The Forest Service will not make a leasing decision on other federal leasable minerals, but will consider whether leasing other federal leasable minerals would be a suitable use for various management prescriptions.

Other Federal Leasable Minerals

Historically, iron mining and some coal mining occurred on the Forest. But there is no recent interest in these or other hardrock leasable minerals. Some geothermal leasing occurred on the Forest in the 1980s, but there has been no recent interest in geothermal leasing.

The Forest does not have any lands subject to mining claims under the Mining Law of 1872 ("locatable minerals"). Minerals, such as metallic minerals, that would be locatable minerals on public domain lands in the western U.S. are leasable minerals on acquired lands in the eastern U.S. As a result, leasable minerals on the Forest include not only oil, gas, coal, and geothermal, but also hardrock or locatable minerals such as iron, manganese, and gold.

Under the Revised Forest Plan, if a company were to apply for a leasable mineral other than oil and gas for some area on the Forest, then an environmental analysis including public involvement would be conducted by the Forest Service in cooperation with the BLM. Then the federal government would decide whether to issue a lease.

Federal Mineral Materials

Mineral materials include aggregate, landscaping rock, rip-rap, flagstone, and other rock or earth construction materials. Mineral materials are managed by the USDA Forest Service (36 CFR 288C) and are not federal leasable minerals. Mineral materials are essential to manage the Forest and provide public access. The Forest operates pits or quarries to supply mineral materials to support a wide range of management programs: to build and maintain trails, roads, campgrounds; to control erosion and sedimentation; to restore riparian and

aquatic habitat; to prevent or repair flood damage; etc. The Forest also uses mineral materials extracted from mines off the Forest. Most of the mineral materials used by the Forest are extracted from mines off the Forest.

The Forest also issues mineral material permits to the public. The Forest also can make mineral materials available as free use to governmental agencies, such state road departments. A continuing supply of mineral materials is essential to manage the Forest and provide public access. As a result, all alternatives require some level of continued mining to supply mineral materials required to implement the alternative. Under all alternatives, most of the mineral materials for Forest management would likely be supplied by mines off the Forest, with lesser amounts of mineral materials supplied by sources on the Forest.

Private Mineral Rights (Reserved and Outstanding Mineral Rights)

Private mineral rights (reserved and outstanding mineral rights) underlie about 16 percent of the Forest (Figure 3D-1). These outstanding or reserved mineral rights (non-federal mineral rights) are partial or complete mineral interests. Reserved rights are those retained in part or in whole by the seller when the federal government acquired the tracts comprising the National Forest. Outstanding rights are mineral rights owned and retained by a third party when federal government acquired the tracts comprising the National Forest. Of the privately-owned mineral rights, about 76 percent are mineral rights outstanding to third parties, and 24 percent are mineral rights reserved by the grantor at the time of acquisition by the federal government.

The only active operation under private mineral rights is a shale mine in operation since the 1980s on the Pedlar Ranger District. Since 1993 reclamation of the previous shale mine has occurred, while additional mining has occurred in recent years. In 2005 the James River Ranger District received a proposal to exercise private mineral rights by mining. Forest Service requested additional information about the proposal but has not received the information. To date, the proponent has not pursued the proposal with the Forest Service.

Just because mineral rights are privately owned does not automatically mean that the mineral rights will be exercised to explore and develop minerals. In fact, the exercise of private mineral rights on the George Washington National Forest going back for decades is rare. Mineral deposits suitable for mining are scarce on the Forest. For example, there has never been a private mineral rights oil and gas well developed on the George Washington National Forest. However, due to recent interest in natural gas in the Marcellus Shale, the future has the potential for an increase in exploration and development of private mineral rights on the Forest.

Private mineral rights are constitutionally protected property rights. Forest Plan regulations (36 CFR 219.22) require that outstanding and reserved mineral rights (private mineral rights on NFS lands) shall be recognized to the extent practicable in Forest planning.

A Comptroller General Report to Congress (GAO/RCED-84-101; July 26, 1984) found that the Forest Service in the eastern U.S. failed to provide Congress with information about private mineral rights and their potential effect on wilderness management. After designating many Wilderness areas in the eastern U.S., Congress was concerned about tens of millions of dollars that the Forest Service then said could be needed to acquire private mineral rights in several Wildernesses. The Forest Service was faced with management problems, litigation, and administrative costs, and was looking to Congress to purchase the private mineral rights. The GAO noted: "Recent attempts by the federal government to acquire private mineral rights and prevent development in eastern wilderness areas have caused considerable controversy and congressional debate primarily because of the high costs associated with these purchases."

The GAO recommendation to the Secretary of Agriculture was: "Because the Forest Service did not analyze the potential problems or costs associated with private mineral rights when it developed its 1979 wilderness recommendations, GAO recommends that the Secretary direct the Forest Service's southern and eastern regional offices to do this type of analysis when reevaluating its wilderness recommendations. This analysis should include for each area consideration of private mineral development potential, the government's ability to control mineral development if it occurs, the need to acquire private mineral rights, and a range of acquisition costs."

These problems (management conflicts, litigation, and high costs) apply not only to Wilderness, but to 1) any highly restrictive surface use designation that conflicts with exercise of private mineral rights on National Forest System lands, and 2) management area direction that impose severe restrictions on use of the surface or prohibit certain activities such as road construction or mining. Examples include Special Biological Areas, Appalachian Trail locations or relocations, Wild & Scenic River designations, Recommended Wilderness Study Areas, or Remote Backcountry prescriptions.

The 5th Amendment to the U.S. Constitution provides that private property shall not be taken for public use without just compensation. In addition to designations or Plan direction that prohibit mining or are de facto prohibitions on mining, a "taking" can have other forms. For example, the time required to process private mineral activities under the Forest Plan's framework might result in unreasonable delays that amount to a "taking" of the mineral rights. Executive Order 12630 "Governmental Actions and Interference with Constitutionally Protected Property Rights" requires federal decision-makers to 1) evaluate carefully the effect of their administrative actions on private property rights, and 2) to show due regard to these 5th amendment rights and to reduce the risk of undue or inadvertent burdens on the federal treasury. Concern about government "takings" of private property rights is a national issue.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

For effects related to federal oil and gas leasing, refer to Section D of this Chapter.

Effects Associated with Forest Demand for Mineral Resources

The consumption of, and irretrievable commitment of, non-renewable mineral resources would vary by alternative. The estimates in the following table indicate 1) the order of magnitude of the effect on mineral resources, 2) the relative differences between Alternatives.

Under the current Plan (Alternative A) the annual gasoline and diesel consumption for Forest administration is estimated to be about 100,000 gallons. The consumption will vary by alternative depending on the amount of on-the-ground activities. The Acres of Soil Disturbance by alternative (Table 3A6-3) was used as an indicator of field activities. The table for fuel consumption uses 100,000 gallons of Alt A as the base (100%) and then calculates the gallons for each Alt based on the proportional change in activities from the Acres of Soil Disturbance.

Table 3C7-1. Estimated Annual Gas/Diesel Consumption for Forest Administration (thousands of gallons)

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Annual Fuel Consumption (thousand gallons)	100	98-144	66	152-227	96-140	76-110	101-147

The diesel consumption for truck log hauling for GWNF timber harvest was estimated using Forest appraisal information, and is estimated to be about 7 gallons per CCF. Truck log hauling typically is the largest user of fuel on a timber sale, and can be 50 percent of the cost of a timber sale. The diesel and gasoline consumption for other timber harvest operations (road work, landing construction, felling, bucking, yarding, etc.) is estimated to be about 7 gallons per CCF. The total diesel/gas consumption per CCF harvested on the Forest is estimated to be about 14 gallons per CCF. This estimate was applied to the Allowable Sale Quantity for All Products by Decade (CCF) in Table 3C6-8 to develop Table 3C7-2.

Table 3C7-2. Estimated Annual Gas/Diesel Consumption for Forest Timber Harvest (thousands of gallons)

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Annual Fuel Consumption (thousand gallons)	658	781	0	1,481	435	267	773	774

Under the current Plan (Alternative A) it is estimated that the public consumes on the order of 4 million gallons of gasoline/diesel a year traveling to the GWNF. Using the estimated capacity (PAOTs) of developed recreation areas as an indicator of National Forest visits by the public (Table 3C1-11), the gasoline and diesel consumption by visitor travel for Forest recreation by alternative is estimated in Table 3C7-3 by using the alternative's proportion of PAOTs relative to Alternative A.

Table 3C7-3. Estimated Annual Gas/Diesel Consumption for Forest Public Recreation (thousands of gallons)

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Annual Fuel Consumption (thousand gallons)	4,000	4,000 - 4,200	3,400 - 3,800	4,000	3,400 - 3,800	4,200 - 4,600	4,000-4,200

From the Forest's establishment up to the present, the Forest has been primarily a user of, rather than a supplier of, mineral resources. In the future, the administration of the Forest as well as timber harvest and recreation will continue to require mineral resources regardless of whether or not the Forest supplies any mineral resources. The consumption of gasoline/diesel for these major consumers of fossil fuels is estimated for decade 1 in Table 3C7-4. The consumption of gasoline/diesel by potential federal oil and gas operations is shown and added to the subtotal in Table 3C7-4.

Table 3C7-4. Estimated Gas/Diesel Consumption for Decade 1 (millions of gallons)

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Forest administration*	1.0	1.2	0.7	1.9	1.2	0.9	1.2	1.2
Timber Harvest	6.6	7.8	0.0	14.8	4.4	2.7	7.7	7.7
Recreation*	40.0	41.0	36.0	40.0	36.0	44.0	41.0	41.0
Total	47.6	50.0	36.7	56.7	41.5	47.6	50.0	50.0

*Based on midpoint of range in annual gas/diesel consumption tables

Mineral materials (aggregate, rip-rap, stone, etc.) – Because roads use the most mineral materials, the projected miles of road in the minimum road system at the end of 10 years will be used as one indicator of the effect of each Alternative on mineral material use. Based on Table 3C8-2 Road construction and Decommissioning miles, Alternative A has the potential for most use of mineral materials; and Alternative C has the potential for least use of mineral materials; Alternatives D, B, G, H, I, E and F have potential for intermediate levels of use of mineral materials.

Effects Associated with Forest Supply of Mineral Resources

Federal leasable minerals other than oil and gas - The areas of suitable use for leasable minerals other than oil and gas vary by alternative and depend on the mix of prescriptions with permissible suitable uses in each alternative. Alternative A provides the most areas and Alternative C the least areas of suitable use for leasable minerals other than oil and gas; Alternatives F, B, E, G, H, I and D provide intermediate levels of areas of suitable use for leasable minerals other than oil and gas.

In terms of potential effects from ground disturbing activities associated with leasable minerals other than oil and gas, Alternatives A and D have the most potential and Alternative C has the least potential for effects; Alternatives F, B, E, G, H and I have intermediate potential for effects. The potential for the Forest to receive a request for a leasable mineral other than oil and gas that would result in actual exploration or development activity in the next 15 years is estimated to be low.

Federal mineral materials (36CFR228C) - The areas of suitable use to meet demand from the public and from public agencies for mineral materials vary by alternative and depend on the mix of prescriptions with permissible suitable uses in each alternative. Alternative A provides the most areas and Alternative C the least areas of suitable use to meet public demand; Alternatives F, B, E, G, H, I and D provide intermediate levels of areas of suitable use to meet public demand.

In terms of potential effects from ground disturbing activities associated with Forest administrative use and public use of mineral materials, Alternatives A and D have the most potential and Alternative C has the least potential for effects; Alternatives F, B, E, G, H and I have intermediate potential for effects.

Outstanding and reserved mineral rights - There are two potential effects relating to outstanding and reserved mineral rights:

- The potential effects of outstanding and reserved mineral operations on federal surface management. The reasonably foreseeable development relates to exploration and development of Marcellus shale. These effects for each alternative are considered as part of the cumulative effects in federal oil and gas leasing section, Section D of this Chapter.

- Potential effects of highly restrictive surface management direction on the exercise of outstanding and reserved mineral rights on the National Forest, such as the potential for taking of private mineral rights due to federal action or inaction that prevents or unreasonably delays private mineral operations in some areas. These potential effects are discussed below.

The federal government acquired about 16% of the Forest subject to private mineral rights (reserved or outstanding mineral rights). The exercise of private mineral rights to explore and develop minerals on NFS lands is a private decision, a constitutionally protected property right.

All alternatives are subject to these existing private rights (outstanding and reserved mineral rights).

Failure to consider private mineral rights under the Forest when allocating management prescriptions and selecting an alternative could produce incompatible and conflicting land uses, resulting in 1) unnecessary and preventable resource conflicts, 2) inability to achieve desired future conditions in some areas, 3) public controversies that could have been avoided, 4) situations ripe for takings of private mineral rights, 5) multi-million costs to federal government to avoid potential takings. The potential for conflict with the exercise of private mineral rights is particularly high where management activities are prohibitive or severely restrictive, such as in recommended wilderness study areas or inventoried roadless areas. The alternatives vary in the extent to which they create potential conflicts with private mineral rights. An indicator of the potential for conflict is the degree of restrictions or prohibitions that the alternatives place on federal oil and gas leasing availability. Ranging from least potential to most potential for conflict and potential takings of private mineral rights are Alternatives A, B, D, G, H and I, F, E, and C.

Past and present actions have had limited conflict with the exercise of private mineral rights on Forest. Future actions under Alternative A would result in similar cumulative effects. Alternative B, D, G, H, I, F, E, and C increase the potential for conflict with the exercise of private mineral rights on Forest, and so, increase the potential cumulative effects relating to conflicts.

C8 - ROADS SYSTEM MANAGEMENT

AFFECTED ENVIRONMENT

System roads of the George Washington National Forest currently total 1,823 miles and serve a variety of resource management and access needs. Over the past several years, the system has been fairly stable with regards to total mileage, Objective Maintenance Level (OML) breakdown, and type of resource management support.

There is an effort currently ongoing with regards to management of the Forest road system referenced as a Travel Analysis Process (TAP). This effort is aimed at the identification of the minimum road system necessary to meet management objectives and identify opportunities for increased resource protection, eliminating the backlog of deferred maintenance, optimal performance of maintenance, and better service to Forest users. Road recommendations based on the TAP are incorporated into the Forest Plan and should be further analyzed and implemented through project level NEPA.

One strategy identified in the TAP includes identification of roads that would be better and more efficiently maintained as a Forest Highway with the primary maintainer being the Virginia Department of Transportation (VDOT). These include current Forest roads that have a primary function of other than Forest access and use. Examples include roads that primarily function as commuter routes for work and school or service private property. Currently, 804 miles of George Washington National Forest roads are Forest Highways. An additional 107 miles have been identified as possible candidates for addition to the Forest Highway system. It is anticipated that at least a portion of the 107 miles of road will be upgraded and converted to a Forest Highway within the next decade. Special use permit roads are roads identified in the TAP as not needed for Forest Service management but provide access for a permitted or special use by an other than Forest Service entity. Maintenance responsibility for these routes is borne by the permitted entity. Where these routes are no longer needed, used or not being maintained, they will be decommissioned.

TAP should be implemented through the extensive use of project level roads analysis for decisions regarding changes to the road system. These analyses will be conducted to provide managers with data to make informed decisions concerning road system changes, additions, and deletions. Analyses will be conducted in accordance with current Forest Service Guidelines. A completed analysis will inform future management decisions on the merits and risks of building new roads in previously unroaded areas; relocating, upgrading, or decommissioning existing roads; managing traffic; and enhancing, reducing, or discontinuing road maintenance (USDA Forest Service 1999).

Table 3C8-1. Maintenance Levels of Current Road System and Transportation Analysis Process (TAP) Objective, miles

Description	Operational Maintenance Level - Current Condition	Objective Maintenance Level - TAP	Change from Current
Maint Level 1	245	155	(90)
Maint Level 2	1,008	1,013	5
Maint Level 3	465	301	(164)
Maint Level 4	97	33	(64)
Maint Level 5	8	5	(3)
Decommission	1	160	159
Special Use	-	50	50
Existing Forest Highways	810	810	-
Potential Forest Highways	-	107	107
Grand Total	2,634	2,634	
Minimum Road System	1,822	1,507	
% of High Clearance roads	69%	77%	9%
% of Passenger Car roads	31%	23%	-9%

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

The reasonable foreseeable development and decommissioning scenario is based on the TAP and the amount of acres harvested for each alternative and summarized in Table 3C8-2 below.

Table 3C8-2. Road Construction and Decommissioning, miles

Description	Alt A	Alt A¹	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Current Roads	1,805	1,805	1,805	1,805	1,805	1,805	1,805	1,805	1,805
Special Use Roads – Not part of Minimum Roads System	50	50	50	50	50	50	50	50	50
Potential Forest Highways – Not Part of Minimum Roads System	129	129	129	129	129	129	129	129	129
Roads to be Decommissioned			160	160	80	160	160	160	160
Potential Additional Decommissioning from Future Wilderness Designation	0	0	2	147	6	4	26	2	4
Acres Timber Regeneration Harvest	2,400	700	3,000	0	4,250	1,800	1,000	3,000	3,000
Road Construction (miles during decade)	29	18	15	0	41	9	5	15	15
Minimum Road System at End of 10 years	1,655	1,644	1,479	1,319	1,581	1,471	1,445	1,479	1,477

Alt¹ represents the actual implementation level of the 1993 Forest Plan

As Table 3C8-2 indicates, the largest potential increases in road mileage over the Plan period are in the areas of timber management. In comparison, the potential contributions to road system mileage for Recreation and related activities is relatively small and would, under all the alternatives, be offset by the planned rate of decommissioning. This table indicates that the potential net mileage range from a low of 1,383 miles for Alternative C to a potential high of 1,695 miles for Alternative A over the plan period.

Alternative C could result in additional decommissioning of roads, since many of the closed roads and administrative use roads would no longer be needed for vegetation management activities. It is estimated that up to 200 miles of additional closed roads could be decommissioned, but it is difficult to quantify the extent of the needs for these closed roads.

Management of the Forest's roads will also include intensive on-the-ground field condition surveys followed by clear and concise reporting of the existing condition. This process will include condition surveys on a random sample of the Forest's Operational Maintenance Level (OML) 1, 2, 3, 4, and 5 roads each year. Maintenance levels are recommended in the TAP and summarized in Table 3C8-3.

Table 3C8-3. Maintenance Levels and Road Status, miles

Maintenance Level	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Maintenance Level 1 - Closed in storage for future use	249	238	155	100	217	147	137	153	151
Maintenance Level 2 - High Clearance, seasonal or admin	967	967	1,003	912	1,043	1,004	994	1,005	1,005
Maintenance Level 3 - Passenger Car	379	379	281	268	281	280	274	281	281
Maintenance Level 4 - Passenger Car, collector	56	56	32	32	32	32	32	32	32
Maintenance Level 5 - Passenger Car, 2-lane, paved, arterial	5	5	8	8	8	8	8	8	8

Alt[1] represents the actual implementation level of the 1993 Forest Plan

Table 3C8-4 displays an estimate of the road closure status by alternative. Road closure status can be affected by many site specific factors relating to road stability, wildlife and recreation settings and resource needs, so these are only estimates.

Table 3C8-4. Road Closure Status, miles

Closure Status	Current Road Miles	Miles of Road by Closure Status at End of First Decade								
		Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Closed	223	252	241	157	70	221	150	135	157	156
Admin	557	557	557	526	454	564	525	514	526	525
Seasonal	424	424	424	369	369	369	369	369	369	369
Open	601	601	601	606	606	606	606	606	606	606

Alt[1] represents the actual implementation level of the 1993 Forest Plan

C9 - LAND USE

AFFECTED ENVIRONMENT

The proclamation boundary of the George Washington National Forest encompasses almost 1.8 million acres, however only approximately 59% of those acres are National Forest system land, or land acquired by the National Park Service and administered by the Forest Service. National forest land is interspersed with land that remains in private ownership.

The Forest property boundaries total approximately 3,000 miles. In an ongoing effort, 40% of these boundaries have been marked and can be readily identified by the general public. Generally, forest ownership consists of mountains and ridge tops, with the valleys remaining in private ownership. This results in an ownership pattern that is long and narrow and for that reason; there are few opportunities in a north/south direction to get from the west side of the forest to the east side without crossing national forest at some point.

Table 3C9-1. Boundary Lines and Planned Level of Maintenance

District	Boundary Miles	Range of Boundary Line Maintenance (Miles per Year)	
		Low	High
Lee Ranger District	614	17	26
North River Ranger District	801	30	45
Pedlar Ranger District	468	20	30
Warm Springs Ranger District	496	16	24
James River Ranger District	611	17	26
Total	2,990	100	150

The intermingled ownership pattern causes some Forest tracts to be inaccessible to the public and difficult to manage.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

All alternatives have similar land adjustment programs aimed at consolidating national forest ownership, however each alternative has a different emphasis or priority. Lands are to be added through either acquisition or exchange.

C10 - SPECIAL USES

AFFECTED ENVIRONMENT

All occupancy or use on NFS lands that are not directly related to timber harvest, grazing, mining activities, and recreation are referred to as 'non-recreation special uses.' Typically non-recreation special uses includes: roads, easements, storage facilities, agricultural improvements, locations of scientific equipment, dams, communication sites, and utility/energy transmission infrastructure. Recreation special uses include: outfitter & guides, and a variety of uses that provide access to NFS lands by commercial ventures. Special use authorizations are issued for multiple purposes to individuals, corporations, and other government agencies for uses that are determined to be in the public interest and are compatible with management direction in the Forest Plan. Proposals for use are screened prior to acceptance and if accepted for consideration, undergo a site-specific environmental analysis. The predominant uses are for public roads, communication facilities, and utility rights-of-way. Water uses are the next major use category and private road access is the fifth major use category. The total number and acres of area under permit are summarized below, as of November 2010.

Table 3C10-1. Special Use Permits

District	Permits	Acres
Lee	85	351
North River	99	1,588
Pedlar	75	514
Warm Springs	72	713
James River	75	1,397
Totals	406	4,563

Special use authorizations for personal use are a minor land commitment such as private road easements and permits, well/springs, cultivation, etc. There are no authorizations for recreation residences on the Forest. Recreation special uses such as those for outfitter/guides and competitive recreation events provide recreation opportunities to the public that the Forest does not provide.

Each land use authorization contains terms and conditions designed to protect the public interest in accordance with applicable statutes, rules and regulations. Periodic reviews and inspections of land uses seek to ensure that the terms and conditions are met and to identify and correct non-compliance with permits.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

None of the alternatives propose any site-specific changes to existing special use authorizations on the GWNF. With such a fragmented ownership pattern and increasing development along its boundaries, the GWNF is expected to see a continuing increase in requests for special use permits, ranging from minor private road easements to requests for new utility corridors or rights-of-way (e.g. fiber optic cables) and communication sites. The Forest is also expecting an increase in the requests from existing permittees to upgrade existing aboveground transmission lines, underground pipelines, communication site facilities, and dams to meet new regulatory requirements, replace deteriorating structures, meet increased demands or implement new technology.

The potential for new special use permits could vary by alternative since one evaluation factor is whether it is compatible with the management prescription for the area in question. There could be a higher number of new special use permits in Alternative D since one of the emphases is to support economic development of local communities. Alternatives C and F would have the lowest potential for new special use permits because of the

amount of land allocated to more management prescriptions (e.g. Recommended Wilderness Study, Recommended National Scenic Areas, Remote Backcountry) where new special uses are not allowed or road construction is limited.

Due to the ownership pattern of the Forest, sometimes the infrastructure needed for energy transmission, communications, water, and other services cannot be provided or developed on private lands without crossing National Forest Service lands. Without the use authorized in the Forest, this could result in diminished public health and safety, community services, economic growth and sustainability or could result in increased environmental impacts on private lands.

Non-recreational special uses also generate revenue for the federal government (see Chapter 3, Section C12, Social and Economic Environment).

Utility Corridors

AFFECTED ENVIRONMENT

Rights-of-way 50 feet and greater in width located within designated utility corridors comprise linear rights-of-way under authorization, and are primarily electric lines in excess of 138,000 kV and natural gas transmission lines.

Facilities in utility corridors are authorized by special use authorization. When compatible, new uses are accommodated by widening existing corridors rather than designating new corridors.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Utility corridors can provide a grassland/shrubland that is beneficial for wildlife species but require mechanical or chemical treatment of unwanted vegetation and non-native invasive species.

All alternatives designate areas as unsuitable for new utility corridors in certain areas (i.e. Wilderness), with Alternative C having the most area designated as unsuitable. In addition to those areas where new corridors are unsuitable, all alternatives also discourage or somehow restrict development of new corridors in additional management prescription areas.

Although all alternatives have areas where new corridors are considered unsuitable and also restricted, there are opportunities under each alternative to cross NFS lands with new utility corridors.

Communication Sites

AFFECTED ENVIRONMENT

There were eleven classified communications sites on Forest in the 1993 GWNF Plan. Three additional sites that have existed for many years are designated through this planning process. The Alleghany County site was approved through a non-significant amendment to the 1993 GWNF Forest Plan in March 2014. Most have multiple users that conduct high powered broadcasts typically AM, FM radio, television and cellular communications. Some are considered low power sites that use less than 1,000 watts of radiated power (ERP) for radio communications. The Forest Service also uses many of these sites for its own radio communications. Access is predominately by state highway to a Forest Service road to the site. Sites are summarized in Table 3C10-2.

Table 3C10-2. Communication Sites

District	Site	Year Approved	Use	FS Use	Use Type
Lee	Signal Knob	1978	Single	No	High and low Power
Lee	Great North Mtn	1980	Multiple	Yes	High and low Power
Lee	Big Mtn	1978	Multiple	Yes	High and low Power
North River	Elliot Knob	1977	Multiple	Yes	High and low Power
North River	White Grass Knob	1982	Single	No	Low power
North River	Narrowback Mountain	1993	Single	No	High power
James River	North Mountain	1979	Multiple	No	Low power
James River	Fore Mountain	1994	Single	Yes	High and low Power
James River	Harmons Branch	1966*	Single	No	Low power
James River	Alleghany County	2014	Multiple	No	Low power
Pedlar	Rocky Mountain	1977	Multiple	Yes	High and low Power
Warm Springs	Duncan Knob	1977	Multiple	No	Low power
Warm Springs	Little Back Creek	~1980*	Multiple	No	Low power
Warm Springs	Bald Mountain	~1980*	Multiple	Yes	Low power

*Existing sites being designated as communication sites

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Communication facilities have been found to have detrimental effects on some mammal and migratory bird species and also affect visual resources. Site-specific analysis will address these concerns during construction of new towers or replacement of existing towers.

All alternatives designate areas as unsuitable for new communication sites in certain areas (i.e. Wilderness). In addition to those areas where new sites are unsuitable, all alternatives also discourage or somehow restrict development of new sites in additional management prescriptions, with Alternative C having the most and Alternative D being the least restrictive.

Although all alternatives have areas where new sites are considered unsuitable and also restricted, the effect on the establishment of a nationwide communication system is negligible. The major demand for new communication sites nationwide is to provide wireless coverage. Due to the interspersed ownership pattern of NFS lands, with the mountain ridges being in Forest ownership and the valleys being held in private ownership, most wireless sites are best located on private land along major travel ways and not on ridge tops located well away from these roadways. As the wireless communication grid expands to more rural locations, the need for demand for new sites is anticipated to increase, however it is expected that for the most part, in the foreseeable future, this need will be able to be met by locating at existing sites, co-locating on electric transmission towers and other improvements, or by locating on private land.

C11 – RANGE

AFFECTED ENVIRONMENT

These lands include approximately 155 acres of improved pastures on three allotments, all on the Lee District. Livestock grazing of cattle is used primarily to help maintain these lands in an open grassland or grass/forb/shrub stage and to preserve the open, pastoral setting on selected portions of the Forest. While these areas provide forage for livestock and aid the local economy, they also to provide a variety of recreational opportunities such as maintaining scenic views, picnicking, and wildlife viewing. These early successional habitats along with their intermingled, isolated patches of woodlands also provide valuable habitat for a variety of wildlife species including deer, turkey, rabbits, voles, raptors, and a variety of migratory songbirds. Livestock grazing has a long history in this area. It is likely the earliest settlers capitalized on the open grassland conditions of the Great Valley and other significant open areas that were maintained for centuries by Native Americans and animals such as bison and elk.

Livestock grazing is managed through a site-specific Allotment Management Plan and Environmental Assessment supported by a thorough analysis of the range situation as directed by the 2200 section of the Forest Service Manual and pertinent handbooks. All grazing use is by permit only. Grazing of livestock on National Forest requires the development of a variety of range improvements and livestock control measures. These include structures such as fences, water developments, corrals, gates and cattleguards. Most of these improvements are typically constructed by the Forest Service and maintained annually to Forest Service standards by the grazing permittee. In most cases, funding from all available sources is insufficient to meet the needs of this program on all these lands.

Forage production appears good on most allotments and livestock numbers are adjusted as necessary to meet the carrying capacity and provide for wildlife needs. Even though the allotments are grazed to maintain the pastoral setting of these lands, impacts on soils and water are occurring. The Moody, Whitting, and Zepp Tannery allotments are currently being grazed with varying degrees of riparian protection or animal access to stream channels.

Although pastureland acreage has been significantly reduced over the last 50 years, pastures still comprise approximately 7 percent of the Southeastern United States (USDA Forest Service 2001). For Southern Appalachian Assessment Area, pastures comprise approximately 17 percent of the area, 99 percent of which is on private land (SAMAB 1996).

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

Grazing is a small program on the GWNF. Grazing would likely continue at current permitted levels on the three current allotments under all alternatives except C. It would continue as long as it is useful in maintaining the desired habitat and not causing damage to other resources. Under Alternative C, grazing under permit would be discontinued. The current grazing allotments are part of the grassland/shrubland ecotype on the GWNF, an important habitat component for many high priority species, especially area sensitive grassland species. If these areas were not grazed, they would continue to be managed as grassland/shrublands, with the possible exception of those allotments located along the South Fork of the Shenandoah River, where bottomland hardwood restoration is a priority goal.

C12 – SOCIAL AND ECONOMIC RESOURCES

An analysis of social values and economic conditions helps evaluate the complex interactions of the surrounding human environment with the biological and physical resources of the Forest. The social and economic influences of people can impact the condition of, and demand for, natural resources. Similarly, almost all National Forest management activities have the potential to directly or indirectly affect the social and economic environment, through people's values, beliefs and attitudes as well as the economic and social structures of communities. This section first characterizes and then evaluates potential impacts related to social factors (demographics, values, resource management concerns and opportunities); economic factors (jobs, income, federal payments, economic diversity and dependency of local communities); and the financial efficiency (present net values) of the agency's resource programs. More details on social and economic conditions, such as data by county, can be found in Appendix C of the Analysis of the Management Situation for the GWNF.

On a regional level, the George Washington National Forest (GWNF) is located at the northern end of the Southern Appalachian Mountains. The Southern Appalachian Mountains range from the Shenandoah Valley and extend southward from the Potomac River to northern Georgia and the northeastern corner of Alabama. The Southern Appalachian Mountains include seven states and 135 counties, covering approximately 37 million acres. On a more local level, the George Washington National Forest occupies approximately 1,065,000 acres, of which about 90% are in Virginia and 10% are in West Virginia. These acres occur in thirteen counties in Virginia and four counties in West Virginia and are in close proximity to Washington, DC, as well as several cities in central Virginia such as Richmond and Charlottesville. The region surrounding the Forest is a mix of ownerships, ranging from the Monongahela National Forest on the west, the Jefferson National Forest on the south, the Shenandoah National Park (USDI National Park Service) on the east, a number of state parks and forests, and an extensive intermingling of private lands. This highlights the unique niche that the GWNF fills in connecting biological habitat and resources for ecological and species diversity and in providing social and economic opportunities for a large and growing population base.

The bounds for most social and economic effects are defined by the counties that contain lands administered by the George Washington National Forest. However, the Jefferson National Forest and the Monongahela National Forest also have land within several of the same counties. Table 3C12-1 identifies the acres of federal and state ownerships within the 17 counties that contain GWNF lands so that one can see the cumulative influence of public ownership within these counties. For the counties containing GWNF lands, Bath and Alleghany Counties have about 50 percent of their acres comprised of GWNF lands. Five additional counties (Amherst, Augusta, Highland, Rockingham, and Shenandoah) have from 20-30% of their acres comprised of GWNF lands. Together with additional national forest systems lands for the Jefferson and Monongahela National Forests, the total amount of national forest system lands in Botetourt and Pendleton Counties increases to 23% and 29%, respectively, of total county acres.

In Virginia, some social and economic data for independent cities are reported separate from county data. The following GWNF counties have the associated independent city data included in the effects analysis for social and economic effects: Alleghany County – Covington city; Augusta County - Staunton and Waynesboro cities; Frederick County – Winchester city; Rockbridge County - Buena Vista and Lexington cities; and Rockingham County – Harrisonburg city.

Table 3C12-1. Federal and State Ownership Acres in Counties with GWNF Lands

County, State	Total County Acres	George Washington National Forest Acres	% GWNF Acres of Total County Acres	Other National Forest Acres	National Park Service Acres	State Acres
Alleghany, VA	290,703	141,866	49%			385
Amherst, VA	306,333	57,877	19%		2,224	
Augusta, VA	643,628	196,057	30%		16,299	12,393
Bath, VA	341,984	173,705	51%			17,395
Botetourt, VA	349,262	13,047	4%	68,102[1]	3,222	
Frederick, VA	271,708	4,885	2%			
Highland, VA	266,030	58,255	22%			13,689
Nelson, VA	303,426	19,825	7%		5,129	1,508
Page, VA	200,922	27,082	13%		38,290	
Rockbridge, VA	390,413	45,541	12%	21,306[1]	1,710	22,244
Rockingham, VA	557,093	139,783	25%		37,746	845
Shenandoah, VA	327,906	76,057	23%			360
Warren, VA	138,143	6,290	5%		14,632	1,706
Hampshire, WV	412,342	3,518	1%			18,316
Hardy, WV	373,906	52,047	14%			6,512
Monroe, WV	302,994	428	<1%	18,530[1]		2,740
Pendleton, WV	446,620	49,106	11%	82,038[2]		629
VIRGINIA (above listed counties)	4,387,551	960,270	<1%	89,408	119,252	70,525
WEST VIRGINIA (above listed counties)	1,535,862	105,099	<1%	100,568	0	28,197
TOTAL (above listed counties)	5,923,413	1,065,369	0%	189,976	119,252	98,722

Source: national forest acres are from USDA Forest Service “Land Areas of the NF System”, 2011, http://www.fs.fed.us/land/staff/lar/2011/lar2011index.html; All other acres are from US Census Bureau (2010)
[1] – Jefferson National Forest
[2] – Monongahela National Forest

Social Environment

AFFECTED ENVIRONMENT

Information about population characteristics helps describe the general nature of a community or area. An analysis of population trends can help determine if changes are occurring for specific groups defined by age, gender, education level, or ethnicity, thereby influencing the nature of social and economic relationships in the community.

Population

Virginia's population has steadily increased from 5.35 million in the 1980 Census to 8.0 million in the 2010 Census. This represents a 16% increase between 1980 and 1990, a 14% between 1990 and 2000, and a 13% increase between 2000 and 2010 as shown in Table 3C12-2. However, West Virginia's population has decreased overall from 1.95 million in 1980 to 1.85 million in 2010. Population decreased from 1980 to 1990 by 8%, increased from 1990 to 2000 by 0.8 percent and increased 2.5% from 2000 to 2010. Much of the population growth in Virginia was spurred by growth in the major cities in the state, especially in the northern Virginia-Washington, DC area. West Virginia, meanwhile, does not have many large cities to spur growth and the economy is relatively less diversified than that of Virginia.

Table 3C12-2. Population Change in Virginia and West Virginia from 1980 to 2010

State	Population	1980	1990	2000	2010
Virginia	Total Population	5,346,818	6,187,358	7,078,515	8,001,024
	Population Change from prior period		840,540	891,157	922,509
	Percent Change from prior period		15.7%	14.4%	13.%
West Virginia	Total Population	1,949,644	1,793,477	1,808,344	1,852,994
	Population Change from prior period		-156,167	14,867	44,650
	Percent Change from prior period		-8.0%	0.8%	2.5%

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

The report "Virginia Demographic Profile 2009" from the Council on Virginia's Future (covf@virginia.edu) identified three specific trends as shaping the future for Virginia:

1) **Selective decentralization will increase.** People are moving away from central cities and counties to surrounding suburbs and exurbs. Rural counties adjacent to metro areas are likely to grow in population as space and affordable housing become harder to obtain. Counties with significant quality-of-life advantages, those with access to urban amenities and those with a diversified, service-based economy are prone to rapid growth.
2) **The population will continue to age.** By 2030, nearly one in every five Virginians is projected to be 65 years or older.
3) **Racial and ethnic diversity will increase.** While non-Hispanic Whites will continue to be the majority of Virginia's population in the next few decades, the proportion of Asians and Hispanics will grow.

The Council on Virginia's Future report also estimated that Virginia's 11 metropolitan areas contain about 86% of the state's population. Almost 69% of all Virginians live in just three metropolitan areas: Northern Virginia,

Richmond, and Virginia Beach, all of which are within a few hours' drive from the George Washington National Forest.

Table 3C12-3 shows the population trends by the counties having GWNF lands. When compared to Virginia's overall trends (since the majority of GWNF lands lie in Virginia), the GWNF counties show a growth of more than half the rate of Virginia between 1980 and 1990 (8.9% versus 15.7%), slightly more than Virginia's growth rate between 1990 and 2000 (15.7% versus 14.4%), and a greater growth rate than Virginia's growth rate between 2000 and 2010 (16.6% versus 13%).

Table 3C12-3. Population for Counties with GWNF Lands from 1980 to 2010 (includes independent cities data)

County, State	1980	1990	2000	2010	Change 1980-1990	Change 1990-2000	Change 2000-2010
Alleghany County, VA	23,396	20,167	19,229	22,395	-13.80%	-4.70%	16.5%
Amherst County, VA	29,122	28,578	31,894	32,315	-1.90%	11.60%	1.3%
Augusta County, VA	75,589	79,138	89,468	117,892	4.70%	13.10%	8.2%
Bath County, VA	5,860	4,799	5,048	4,779	-18.10%	5.20%	-5.3%
Botetourt County, VA	23,270	24,992	30,496	32,867	7.40%	22.00%	7.8%
Frederick County, VA	54,367	67,670	82,794	101,788	24.50%	22.30%	22.9%
Highland County, VA	2,937	2,635	2,536	2,395	-10.30%	-3.80%	-5.6%
Nelson County, VA	12,204	12,778	14,445	14,989	4.70%	13.00%	3.8%
Page County, VA	19,401	21,690	23,177	24,116	11.80%	6.90%	4.1%
Rockbridge County, VA	24,628	24,756	27,157	35,860	0.50%	9.70%	5.4%
Rockingham County, VA	76,709	88,189	108,193	122,328	15.00%	22.70%	13.1%
Shenandoah County, VA	27,559	31,636	35,075	41,468	14.80%	10.90%	18.2%
Warren County, VA	21,200	26,142	31,584	37,044	23.30%	20.80%	17.3%
Hampshire County, WV	14,867	16,498	20,203	23,594	11.00%	22.50%	16.8%
Hardy County, WV	10,030	10,977	12,669	13,832	9.40%	15.40%	9.2%
Monroe County, WV	12,873	12,406	14,583	13,495	-3.60%	17.50%	-7.5%
Pendleton County, WV	7,910	8,054	8,196	7,773	1.80%	1.80%	-5.2%
Total Forest Counties	443,902	483,095	558,747	648,930	8.90%	15.70%	16.1%
Virginia (state total)	5,346,818	6,187,358	7,078,515	8,001,024	15.70%	14.40%	13.0%
West Virginia (state total)	1,949,644	1,793,477	1,808,344	1,852,994	-8.00%	0.80%	2.5%

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Population outside of counties with GWNF ownership is also important to consider, especially from a recreation demand perspective. Research on recreation use of National Forests typically suggests that most national forest visits originate from within a 75-mile (1 ½ hour driving time) radius from the national forest border (Overdest and Cordell 2001). Using this definition, the GWNF market area for recreation entails portions of Virginia, West Virginia, Pennsylvania, Maryland, North Carolina and the District of Columbia. The population living within the market area is about 10.54 million (US Census Bureau 2010). The most populated counties in the market area are Fairfax, Virginia, and Montgomery and Prince George's Counties, Maryland, followed by Washington, DC. Other large municipalities within the market area include Alexandria, Arlington, Fredericksburg, Harrisonburg, Lynchburg, Manassas, Richmond, Roanoke, Staunton, Vienna, and Winchester, Virginia; Beckley, Bluefield, Elkins, Martinsburg and Princeton, West Virginia; and Frederick and Silver Spring, Maryland.

Race/Minorities

Different groups of people may value and use public lands in different ways. Understanding those various values, beliefs, and attitudes in an area can be an important consideration to meet the needs of the public, such as developing multilingual communication strategies.

For public land managers, one of the important considerations of proposed management actions is whether the action could have disproportionately high and adverse effects on minority populations. This consideration, broadly referred to as "Environmental Justice", is a requirement of Executive Order 12898. The discussion of Environmental Justice and Civil Rights is provided later in this section.

Table 3C12-4 shows the number of people within the counties that contain GWNF lands who self-identified as belonging to a particular race for the 2010 Census. When comparing those counties to each other, the following counties have a slightly higher percentage of Hispanics or Latinos than the average: Rockingham (9%), Frederick (8%) and Shenandoah (6%). The Census Bureau predicts that 24.4% of the population in the U.S. will be Hispanic by 2050. Between 2000 and 2010, Hispanics accounted for over one-half of the nation's population growth. The following counties have a higher percentage of Blacks or African Americans, compared to other GWNF counties: Amherst (19%) and Nelson (14%).

Table 3C12-4. Racial Composition of GWNF Counties in Virginia and West Virginia in 2010

Race	Number of People	Percentage of Total Population in GWNF Counties
White	570,389	87.90%
Black or African American	33,593	5.18%
Hispanic or Latino (of any race)	29,058	4.48%
Two or More Races	6,962	1.07%
Asian	5,954	0.92%
American Indian	1,522	0.23%
Other	981	0.15%
Native Hawaiian	471	0.07%

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Age

Understanding the age distribution can help highlight whether management actions might affect some age groups more than others. It also may highlight the need to understand the different needs, values, and attitudes of different age groups. If an area has a large retired population, or soon-to-be-retired population, the needs and interests of the public may be focused on easily accessible recreation opportunities. Younger people may want physically challenging mountain bicycling opportunities. For many areas, a significant consideration is the aging of the population, and in particular the retirement of the "Baby Boomer" generation (those born between 1946 and 1964). As this generation enters retirement age, their mobility, spending patterns, and consumer demands (for health care and housing, for example) can affect how communities develop economically. An aging population can also affect changing demands on land use, such as increased opportunities for driving for pleasure or increased parking opportunities for hunters.

Table 3C12-5 shows the share of population by age within the counties having GWNF lands. Within the last ten years, the percentage of people aged 45 and older has increased from 38% of the total population to 43%. On a county comparison level, Bath, Highland and Pendleton Counties have a larger percentage of people aged 65 and older compared to the other counties and a smaller percentage of youth. Rockingham County has a larger percentage of youth in comparison to other counties.

Table 3C12-5. Population Age within GWNF Counties in 2010

Population Age	2000	2010
Total Population	583,134	648,930
Under 18	133,001	142,438
18-34	134,072	141,507
35-44	91,571	86,773
45-64	142,334	178,984
65 and over	82,156	99,228
Percent of Total		
Under 18	22.80%	21.90%
18-34	23.00%	21.80%
35-44	15.70%	13.40%
45-64	24.40%	27.60%
65 and over	14.10%	15.30%

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Population Density

Stein and others (2007) projected future housing density increases on private rural lands at three distances (0.5, 3, and 10 miles) from the external boundaries of all national forests and grasslands in a report entitled "National Forests on the Edge, Development Pressures on America's National Forests and Grasslands." This study ranked National Forest System lands according to the land area of adjacent private lands projected to experience increased housing density. Stein estimated that between 2000 and 2030, a substantial increase in housing density will occur on more than 21.7 million acres of rural private land (8 percent of all private land) located within 10 miles of national forests and grasslands across the conterminous United States. In the East, almost all national forests are projected to experience moderate or high increases in residential development. Of all the national forests and grasslands, the GWNF was found to have the most acreage of increases in housing density, with projected changes on more than 1.4 million adjacent private rural acres by the year 2030. The authors identified several significant implications for the management and conservation of national forest resources, ecological services, and social and cultural amenities from this study, including: impacts on native fish and wildlife habitats and populations; impacts from invasive species, impacts on recreation access, management and quality of recreation experiences; impacts on fire management; impacts on water quality and hydrology; and impacts on law enforcement.

Agricultural Lands

Table 3C12-6 presents a picture of how much a county has in farmlands.

Table 3C12-6. Percent of County Acres in Farmlands, 2007

County, State	% of County Acres in Farmland
Alleghany County, VA	10%
Amherst County, VA	29%
Augusta County, VA	45%
Bath County, VA	11%
Botetourt County, VA	25%
Frederick County, VA	36%
Highland County, VA	29%
Nelson County, VA	24%
Page County, VA	32%
Rockbridge County, VA	36%
Rockingham County, VA	42%
Shenandoah County, VA	43%
Warren County, VA	35%
Hampshire County, WV	32%
Hardy County, WV	36%
Monroe County, WV	44%
Pendleton County, WV	38%
County Region	33%
Virginia	32%
West Virginia	24%

Source: Bureau of Economic Analysis, National Agricultural Statistics Service, Bureau of Labor Statistics, US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Lifestyles, Attitudes and Values

Since the beginning of the George Washington National Forest's planning process, numerous public meetings were held to allow people an opportunity to express their wants, needs and demands for access to and use of national forest resources. Many of these divergent views were used to develop the range of alternatives considered in this analysis. Public meetings, however, typically represent only a portion of the public's interests and do not always represent those who do not or cannot attend meetings.

In Virginia and West Virginia, each county periodically produces a County Comprehensive Plan that is typically a joint effort between the local planning commission, the county board of supervisors and the citizens of the county. The County Comprehensive Plans consider existing trends of development and probable future needs and identifies goals and objectives for the county. By reviewing these plans, the Forest can determine what opportunities it has to contribute to a county's goals and objectives. All of these plans had a recurring theme throughout their plans that identified the importance of the natural environment in determining a county's quality of life. The following goals and objectives were found in most of the plans:

- Preserve the relationship of the county to the surrounding forested and agricultural environment.
- Increase economic development but maintain the rural and cultural character of the county.
- Develop and promote tourism as it relates to the scenic and recreational resources of public lands in the county.
- Wisely use natural resources and protect ground and surface waters, soils, scenery and air quality.
- Several plans also identified the need to protect ridgelines and scenic viewsheds from development.

The Southern Research Station and the University of Tennessee conducted a public survey of residents within 75 miles of Southern Appalachian Mountains national forests concerning the public use and preferred objectives for the management of the southern Appalachian national forests (USDA Forest Service 2002). Survey questions concerned the respondents' (1) values, attitudes, and beliefs at a specific forest level; (2) participation activities on national forest lands; (3) feelings toward natural resource management in general; (4) beliefs on how the national forests should be managed; and (5) concern about various environmental issues in the southern Appalachians.

The public survey provided information on the values residents have related to natural resources in the publication "Public Survey Report Southern Appalachian National Forests, George Washington and Jefferson National Forests." Well over 90% of the sample for the George Washington National Forest market area thought maintaining the forests in good condition for future generations protection of clean water was the most important management goal. The next highest percentages (in the low 90s) included protecting sources of clean water, providing protection for wildlife and habitat, protecting trees for healthy forests, leaving forests natural in appearance, and protecting rare or endangered species. Other values favored by survey participants included management of national forests as sources of raw materials and products to support local industries (38%), permitting of grazing by livestock (44%), helping local tourism businesses (58%), provisions of an abundant timber supply (72%) and outdoor recreation (72%). All of these values were highly consistent with priorities of residents throughout the Southern Appalachian region.

Over 80% of the survey participants thought the top management objectives should include: protection of streams, lakes and watershed areas, protection of wildlife habitats, protection of old growth areas and provision of habitat for wildlife and bird viewing. Almost 65% thought more areas should be designated as wilderness, as well as use of controlled fire was important. About 60% thought provision of trail systems for non-motorized recreation and a diversity of uses such as grazing, recreation and wildlife habitat (in other areas) were important. On the lower end of the spectrum, the objectives from least to greater importance included: allowance of commercial leasing of oil and gas rights, expansion of access for motorized off-highway vehicles, provision of new paved roads for cars and allowance of harvesting and mining to support communities. The priority for these objectives was nearly the same as the average for the entire Southern Appalachian region. People who reside in areas near the GWNF generally put ecosystems, wildlife and naturalness above utilitarian objectives in national forest management. However, as shown in the Economic Impacts section, commodities such as mining and timber can contribute important portions of income and employment to the local economy. Therefore, impacts to the 'naturalness' aspect of the forest are compared with impacts to the 'commodity' aspect of the forest.

Economic Environment

AFFECTED ENVIRONMENT

The Virginia Outdoors Plan (2007) characterizes the economy surrounding the GWNF as being 'driven by a diverse blend of industry, agriculture and tourism. Since the area was first settled, agriculture has been a mainstay of the Shenandoah Valley. During the Civil War, the valley was described as the breadbasket of the Confederacy, with more than 300 armed conflicts waged in the region. With the planning and construction of Interstates 66 and 81 beginning in the 1950s, manufacturing in the valley became more diverse. Second home developments and an extended tourist season led to increased use of the Shenandoah Valley, generating economic benefits and attracting new local residents based on a rural quality of life with access to the Northern Virginia-Washington, D.C. metropolitan area. Many of the region's residents are now employed

outside their home jurisdiction in the northern Virginia area. Increasingly, the Northern Shenandoah Valley's mountain and valley open spaces are giving way to development that is cluttering historic landscapes and causing a loss of the distinctive qualities of the valley. Agriculture, forestry and tourism are the primary industries for the Central Shenandoah Valley. Some of the highest proceeds in the state from agriculture and forestry are received in this region.'

When giving an overview of the economic characteristics of an area, indicators such as per capita income, unemployment rates, poverty rates, and economic industrial sector representation are used to measure economic progress, viability and stability.

Per Capita Income

Per capita income is a relative measure of the wealth of an area. It constitutes the personal income from all sources divided by the population of that area. Understanding income differences within and between areas helps to highlight areas where the population or a sub-population may be experiencing economic hardship.

According to the 2010 Statistical Abstract (US Census Bureau), the per capita income for Virginia was $44,224 (7th in nation) and for West Virginia it was $31,641 (49th in nation). The per capita income and median household income for the counties with GWNF lands are shown in Table 3C12-7.

Table 3C12-7. Per Capita Income and Median Household Income for GWNF Counties, 2010. Independent city estimates are identified exclusive of the county estimates.

County or Independent City	Per Capita Income	Median Household Income
Alleghany County, VA	$22,013	$43,160
Covington city, VA	$20,781	$35,277
Amherst County, VA	$21,097	$44,757
Augusta County, VA	$23,571	$50,612
Staunton city, VA	$24,077	$42,724
Waynesboro city, VA	$23,190	$40,977
Bath County, VA	$22,083	$50,589
Botetourt County, VA	$29,540	$64,724
Frederick County, VA	$27,977	$61,973
Winchester city, VA	$26,341	$44,873
Highland County, VA	$25,690	$43,481
Nelson County, VA	$26,996	$48,118
Page County, VA	$22,969	$41,617
Rockbridge County, VA	$23,753	$44,417
Buena Vista city, VA	$19,030	$39,955
Lexington city, VA	$17,022	$31,571
Rockingham County, VA	$25,274	$49,930
Harrisonburg city, VA	$16,750	$37,235
Shenandoah County, VA	$24,502	$50,171
Warren County, VA	$29,098	$60,522
Hampshire County, WV	$17,752	$31,792

County or Independent City	Per Capita Income	Median Household Income
Hardy County, WV	$16,944	$31,347
Monroe County, WV	$18,927	$39,574
Pendleton County, WV	$19,401	$33,323

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Unemployment and Poverty

Other indicators of relative economic prosperity are the percent of the workforce out of work and percent in poverty. Unemployment rates vary dramatically over time, depending in large part on the national economy, as shown in Table 3C12-9. In 2011, out of the 13 Virginia counties with GWNF lands, seven had unemployment rates higher than the state average, and out of the four West Virginia counties, one had an unemployment rate higher than the state average.

Table 3C12-8. People and Families Below the Poverty Level in GWNF Counties, 2010

County, State	People Below Poverty	Families Below Poverty	People Below Poverty	Families Below Poverty
Alleghany County, VA	2,851	514	13%	8%
Amherst County, VA	4,004	626	13%	7%
Augusta County, VA	13,744	2,800	12%	9%
Bath County, VA	491	99	10%	7%
Botetourt County, VA	1,783	405	6%	4%
Frederick County, VA	10,201	1,723	10%	6%
Highland County, VA	211	43	9%	5%
Nelson County, VA	1,767	403	12%	9%
Page County, VA	3,033	593	13%	9%
Rockbridge County, VA	5,482	960	17%	10%
Rockingham County, VA	20,088	2,379	18%	8%
Shenandoah County, VA	3,811	754	9%	6%
Warren County, VA	3,484	708	10%	7%
Hampshire County, WV	3,759	638	16%	11%
Hardy County, WV	2,055	334	15%	11%
Monroe County, WV	1,778	404	13%	10%
Pendleton County, WV	1,159	244	15%	11%
County Region	79,701	13,627	13%	8%

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Table 3C12-9. Percent Unemployment Rates in GWNF Counties, 1990, 2000, and 2011

County or Independent City	1990	2000	2011
Alleghany County, VA	7.9	3.0	8.3
Covington city, VA	10.0	3.9	9.2
Amherst County, VA	5.1	2.1	7.2
Augusta County, VA	4.0	1.9	6.0
Staunton city, VA	4.3	2.1	6.9
Waynesboro city, VA	4.3	2.6	7.9
Bath County, VA	12.1	2.6	5.4
Botetourt County, VA	3.6	1.8	5.5
Frederick County, VA	5.4	2.0	5.9
Winchester city, VA	6.3	2.2	7.7
Highland County, VA	4.3	2.8	7.0
Nelson County, VA	4.3	2.3	5.4
Page County, VA	13.3	2.6	10.9
Rockbridge County, VA	5.8	2.1	6.5
Buena Vista city, VA	9.1	2.3	8.0
Lexington city, VA	8.0	3.5	11.4
Rockingham County, VA	5.1	1.7	5.5
Harrisonburg city, VA	6.2	2.3	7.3
Shenandoah County, VA	4.8	1.8	7.0
Warren County, VA	7.3	2.0	6.4
Hampshire County, WV	9.5	3.3	7.8
Hardy County, WV	5.8	3.8	8.4
Monroe County, WV	9.5	4.9	7.1
Pendleton County, WV	5.9	7.9	6.5
Virginia	4.5	2.3	6.2
West Virginia	8.6	5.5	8.0

Source: US Department of Labor, Bureau of Labor Statistics

Economic Diversity

Analyzing the major economic sectors of an economy allows insight into the degree of economic diversity and what industries may be driving its growth. Diverse economies are those with a large number of economic sectors. They are more resilient and less vulnerable to downturns in any one sector. The size and vitality of these economic sectors and linkages to other sectors in the economy are also important. If a county economy is heavily dependent on only one sector, it may be vulnerable to declining prosperity if business conditions for that industry deteriorate. Table 3C12-10 is derived from the 2011 IMPLAN model, which is an input-output economic modeling program that uses a database of economic statistics from major government sources such

as the Regional Economic Information System (REIS), Bureau of Economic Analysis, Bureau of Labor Statistics and the US Census Bureau. The industries are defined by North American Industry Classification System (NAICS) Sectors. A brief description of each industry/sector follows the table. The impact study area used in IMPLAN is defined as the counties having GWNF lands.

Employment by Industry

The local economy reflected in Table 3C12-10 shows a fairly diverse distribution among the twenty industries. The Manufacturing and Government Sectors account for 30% of the area's total employment and 42% of the labor income. The Retail Trade and Construction Sectors provide another 18% of the area's jobs and 15% of the labor income. Health Care and Social Assistance provides another 8% of the total employment and 8% of the labor income.

Forest Service-related activities on the GWNF contribute about 0.27% of all area jobs, with a total of about 3% contributed to the jobs within the Agriculture, Forestry, Fishing and Hunting Sector, the Arts, Entertainment and Recreation Sector and the Government Sector.

Table 3C12-10. Current Role of Forest Service-Related Contributions to the Area Economy by NAICS Sector

Industry	Employment (jobs)		Labor Income (thousands of 2012 dollars)	
	Area Totals	FS-Related*	Area Totals	FS-Related*
Agriculture, Forestry, Fishing and Hunting (Sector 11)	10,972	64	$80,850	$1,676
Mining, Quarrying, and Oil and Gas Extraction (Sec 21)	857	1	$38,630	$23
Utilities (Sector 22)	624	1	$94,102	$110
Construction (Sector 23)	18,967	5	$672,359	$176
Manufacturing (Sectors 31-33)	31,775	10	$1,811,431	$488
Wholesale Trade (Sector 42)	5,497	10	$318,870	$580
Transportation & Warehousing (Sectors 48-49)	11,289	10	$583,277	$425
Retail Trade (Sectors 44-45)	20,129	52	$554,733	$1,313
Information (Sector 51)	1,842	2	$99,742	$88
Finance & Insurance (Sector 52)	7,367	7	$301,333	$286
Real Estate & Rental & Leasing (Sector 53)	7,834	10	$95,068	$141
Professional, Scientific, & Technical Svcs (Sector 54)	7,282	9	$313,297	$384
Mngt of Companies (Sector 55)	1,404	1	$96,587	$33
Admin, Waste Mngt & Remediation Services (Sect 56)	8,796	9	$199,359	$190
Educational Services (Sector 61)	3,270	2	$110,361	$73
Health Care & Social Assistance (Sector 62)	17,102	19	$693,082	$698
Arts, Entertainment, and Rec (Sector 71)	3,587	22	$44,490	$290
Accommodation & Food Services (Sector 72)	14,430	59	$255,180	$969
Other Services except Public Administration (Sect 81)	11,892	11	$380,415	$308
Government/Public Administration (Sector 92)	32,337	280	$1,739,943	$9,544
Total	217,252	584	8,483,108	17,796
FS as Percent of Total	---	0.27%	---	0.21%

* FS-Related: Due to substitution effects from competing non-government sources (such as volume of timber harvesting which may occur on private lands if national forest timber is not offered to the market to meet local demand), these jobs are characterized as being related or associated with local economic activity initiated by Forest Service programs and activities, rather than directly caused by these activities.
Source: 2011 IMPLAN data model

Descriptions of NAICS Industries

The Agriculture, Forestry, Fishing and Hunting industry (NAICS Sector 11) includes establishments primarily engaged in growing crops, raising animals, harvesting timber, and harvesting fish and other animals from a farm, ranch, or their natural habitats.

The Mining, Quarrying, and Oil and Gas Extraction Industry (NAICS Sector 21) includes establishments that extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas. The term mining is used in the broad sense to include quarrying, well operations, beneficiating (e.g., crushing, screening, washing, and flotation), and other preparation customarily performed at the mine site, or as a part of mining activity.

The Utilities Industry (Sector 22) comprises establishments engaged in the provision of the following utility services: electric power, natural gas, steam supply, water supply, and sewage removal.

The Construction Industry (Sector 23) comprises establishments primarily engaged in the construction or maintenance of buildings or engineering projects (e.g., highways and utility systems) or in the preparation of sites for new construction.

The Manufacturing Industry (Sectors 31-33) comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. Establishments in the Manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment.

The Wholesale Trade Industry (Sector 42) includes establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing. The wholesaling process is an intermediate step in the distribution of merchandise.

The Transportation and Warehousing Industry (Sectors 48-49) includes industries providing transportation of passengers and cargo, warehousing and storage for goods, scenic and sightseeing transportation, and support activities related to modes of transportation. Establishments in these industries use transportation equipment or transportation related facilities as a productive asset. The modes of transportation are air, rail, water, road, and pipeline.

The Retail Trade Industry (Sectors 44-45) comprises establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The retailing process is the final step in the distribution of merchandise; retailers are, therefore, organized to sell merchandise in small quantities to the general public.

The Information Industry (Sector 51) comprises establishments engaged in the publishing industries, including software publishing, and both traditional publishing and publishing exclusively on the Internet; the motion picture and sound recording industries; the broadcasting industries, including traditional broadcasting and those broadcasting exclusively over the Internet; the telecommunications industries; Web search portals, data processing industries, and the information services industries.

The Finance and Insurance Industry (Sector 52) comprises establishments primarily engaged in financial transactions (transactions involving the creation, liquidation, or change in ownership of financial assets) and/or in facilitating financial transactions.

The Real Estate and Rental and Leasing Industry (Sector 53) comprises establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets. The major portion of this sector comprises establishments that rent, lease, or otherwise allow the use of their own assets by others. The assets may be tangible, as is the case of real estate and equipment, or intangible, as is the case with patents and trademarks.

The Professional, Scientific, and Technical Services Industry (Sector 54) comprises establishments that specialize in performing professional, scientific, and technical activities for others. These activities require a high degree of expertise and training. Activities performed include: legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services.

The Management of Companies and Enterprises Industry (Sector 55) comprises: (1) establishments that hold the securities of (or other equity interests in) companies and enterprises for the purpose of owning a controlling interest or influencing management decisions; or (2) establishments (except government establishments) that administer, oversee, and manage establishments of the company or enterprise and that normally undertake the strategic or organizational planning and decision making role of the company or enterprise.

The Administrative and Support and Waste Management and Remediation Services Industry (Sector 56) comprises establishments performing routine support activities for the day-to-day operations of other organizations. Activities performed include: office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services.

The Educational Services Industry (Sector 61) comprises establishments that provide instruction and training in a wide variety of subjects. This instruction and training is provided by specialized establishments, such as schools, colleges, universities, and training centers. These establishments may be privately owned and operated for profit or not for profit, or they may be publicly owned and operated.

The Health Care and Social Assistance Industry (Sector 62) comprises establishments providing health care and social assistance for individuals. The services provided by establishments in this sector are delivered by trained professionals.

The Arts, Entertainment, and Recreation Industry (Sector 71) includes: (1) establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; (2) establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and (3) establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure-time interests.

The Accommodation and Food Services Industry (Sector 72) comprises establishments providing customers with lodging and/or preparing meals, snacks, and beverages for immediate consumption.

The Other Services, except Public Administration Industry (Sector 81) comprises establishments engaged in providing services not specifically provided for elsewhere in the classification system. Establishments in this sector are primarily engaged in activities, such as equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and providing drycleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services.

The Government/Public Administration Industry (Sector 92) consists of establishments of federal, state, and local government agencies that administer, oversee, and manage public programs and have executive, legislative, or judicial authority over other institutions within a given area.

County Employment

Table 3C12-11 displays a snapshot view (based on Virginia and West Virginia labor statistics websites) of jobs by industrial sector and by county. However, a look at commuting patterns shows that many of the jobs do not necessarily occur within the counties of residence. Of the 17 counties, nine have over 40% of their workforce

who commute outside of their county for work (Amherst, Augusta, Botetourt, Frederick, Page, Nelson, Rockbridge, Rockingham, and Warren), with the majority of commuters likely working in larger metropolitan areas in Northern Virginia, Washington DC, Richmond and Roanoke.

Table 3C12-11. Number of Jobs by Counties with GWNF lands for First Quarter 2012

1st Qtr 2012	Natural Resources & Mining	Con-struction	Trade	Trans-portation & Util	Mfg	Info	Financial	Services	Govt	Other	TOTAL
Alleghany	15	349	1,079	186	1,852	126	175	2,535	1,659	0	7,976
Amherst	68	398	1,258	341	1,237	78	169	2,579	2,808	0	8,936
Augusta	225	2,084	6,987	2,926	7,027	504	1,244	15,531	8,704	0	45,232
Bath	24	129	108	103	41	33	54	1,283	378	0	2,153
Botetourt	148	692	1,608	890	1,907	174	174	2,325	1,451	0	9,369
Frederick	382	2,155	9,173	1,856	6,728	522	1,889	19,662	7,637	0	50,004
Highland	40	37	44		24		49	121	175	0	490
Nelson	259	236	283	107	303	30	103	1758	724	0	3803
Page	28	227	763	58	784	24	149	1,679	1,295	0	5,007
Rockbridge	111	458	1,660	120	2,138	75	352	5,369	2,601	0	12,884
Rockingham	853	2,996	9,507	2,613	10,532	1,397	1,732	19,767	9,985	0	59,382
Shen	195	523	1,754	455	3,234	285	414	3,956	2,270		13,086
Warren	15	376	1,747	1,116	930	58	306	4,934	1,862	0	11,344
Hampshire	45	152	515	39	135		202	1,335	1,415		3,838
Hardy	48	71	592	178	2,769	79	159	1,106	840		5,842
Monroe	37	115	27	25			52	334	753	57	1,400
Pendleton	82	29	196	98		23	69	536	462		1,495
County Totals	2,575	11,027	37,301	11,111	39,641	3,408	7,292	84,810	45,019	57	242,241
%	1.1%	4.6%	15.4%	4.6%	16.4%	1.4%	3.0%	35.0%	18.6%	0.0%	100.0%

Sources: yesvirginia.org/communityprofiles, workforcewv.org

Wood Products Jobs per County

Timber harvest levels on NFS lands within the GWNF declined over the past 15 years. See Timber Management Affected Environment for specific analysis of timber harvest trends. Table 3C12-12 shows number of jobs (full-time and part-time) in the wood products sector for the counties having GWNF acres in 2009.

Table 3C12-12. Local Area Employment in the Wood Products Sector, 2009

County or Independent City	Forestry and Logging	Sawmills and Wood Preservation	Pulp, Paper and Paperboard	Veneer, Plywood and Engineered Wood	Wood Products Mfg	Non-employer Timber Jobs[1]	Total Timber Jobs	%Timber Jobs of Total Jobs in County
Alleghany County, VA	12	67	0	0	38	21	138	5%
Covington city, VA	0	0	1,261	0	0	4	1,265	36%
Amherst County, VA	19	41	312	0	21	32	425	6%
Augusta County, VA	2	46	0	0	270	31	349	2%
Staunton city, VA	0	0	0	0	77	0	77	1%
Waynesboro city, VA	0	0	0	0	164	0	164	2%
Bath County, VA	9	0	0	0	35	9	53	3%
Botetourt County, VA	9	0	0	0	155	23	187	2%
Frederick County, VA	0	302	0	126	181	20	629	3%
Winchester city, VA	0	0	0	13	2	0	15	<1%
Highland County, VA	34	2	0	0	0	7	43	12%
Nelson County, VA	64	7	0	0	4	26	101	3%
Page County, VA	2	0	0	0	328	4	334	7%
Rockbridge County, VA	15	205	0	0	9	33	262	6%
Buena Vista city, VA	2	58	0	63	67	0	190	10%
Lexington city, VA	0	0	0	0	0	0	0	0%
Rockingham County, VA	1	34	0	9	94	30	168	7%
Harrisonburg city, VA	0	0	0	0	155	0	155	1%
Shenandoah County, VA	4	4	0	63	34	16	121	1%
Warren County, VA	0	2	0	0	67	9	78	<1%
Hampshire County, WV	11	64	0	14	14	45	148	5%
Hardy County, WV	2	2	0	0	816	12	832	16%
Monroe County, WV	26	14	0	0	0	44	84	6%
Pendleton County, WV	4	36	0	0	14	27	81	7%
County Region	216	884	1,573	288	2,545	393	5,899	3%

[1] Nonemployer Timber Jobs are usually self-employed individuals operating very small unincorporated businesses, which may or may not be the owner's principal source of income. These are not reported by County Business Patterns but are reported by Nonemployer Statistics. Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Recreation and Tourism Jobs per County

Table 3C12-13 describes the number of jobs (full and part-time) and the share of total jobs in industries that include travel and tourism. Travel and Tourism consists of sectors that provide goods and services to visitors to the local economy, as well as to the local population. These industries are: retail trade; passenger transportation; arts, entertainment, and recreation; and accommodation and food. It is not known, without additional research such as surveys, what exact proportion of the jobs in these sectors is attributable to expenditures by visitors, including business and pleasure travelers, versus by local residents. Components of Retail Trade include Gasoline Stations, Clothing and Accessory Stores, Miscellaneous Store Retailers (includes Gift, Novelty, and Souvenir). Components of Passenger Transportation includes: Air Transportation, Scenic and Sightseeing Transportation. Components of Arts, Entertainment, and Recreation consists of Performing Arts and Spectator Sports; Museums, Parks, and Historical Sites (includes National Parks, Conservation Areas); Amusement, Gambling, and Recreation (includes Golf Courses, Alpine and Cross Country Skiing Facilities).

Table 3C12-13. Employment in the Travel and Tourism Sector, 2009

County or Independent City	Retail Trade	Passenger Transportation	Arts, Entertainment, and Recreation	Accommodation and Food	Percent Travel and Tourism Jobs of Total Jobs within County
Alleghany County, VA	77	0	95	316	11%
Covington city, VA	161	13	8	331	9%
Amherst County, VA	248	0	67	571	8%
Augusta County, VA	528	7	59	1,166	6%
Staunton city, VA	335	0	205	1,446	14%
Waynesboro city, VA	408	0	121	1,232	13%
Bath County, VA	34	0	5	762	43%
Botetourt County, VA	304	65	79	753	7%
Frederick County, VA	750	9	234	1,969	10%
Winchester city, VA	848	0	271	2,208	10%
Highland County, VA	19	0	3	41	11%
Nelson County, VA	90	0	1,008	237	8%
Page County, VA	139	0	128	834	18%
Rockbridge County, VA	461	0	107	851	18%
Buena Vista city, VA	20	0	1	146	8%
Lexington city, VA	108	1	80	713	17%
Rockingham County, VA	325	0	146	2,673	56%
Harrisonburg city, VA	1,145	0	327	4,734	17%
Shenandoah County, VA	477	0	224	1,192	10%
Warren County, VA	335	1	232	1,107	11%
Hampshire County, WV	182	0	2	365	13%
Hardy County, WV	72	0	19	278	5%
Monroe County, WV	50	0	6	73	5%
Pendleton County, WV	48	0	42	117	10%
County Region	7,164	96	3,469	24,115	12%

Source: US Census Bureau data and the Economic Profile System-Human Dimensions Toolkit, at http://headwaterseconomics.org/tools/eps-hdt

Recreation and Tourism Spending Profiles

Stynes and White (2005) analyzed national forest visitor spending profiles developed from the USDA Forest Service National Visitor Use Monitoring (NVUM) project surveys over a four year period. Table 3C12-14 presents the national spending averages across all national forest visits based on the spending reports of 19,113 visitors sampled on 119 national forests between January 2000 and September 2003. Table 3C12-15 shows the national spending averages by several primary activities. Although Stynes and White stated that NVUM economic survey sample sizes are too small at the individual forest level (there were 158 economic survey samples for the GWNF and JNF) to reliably capture spending for individual forests, the authors did estimate that the average spending for day trips on the GWNF and JNF combined as $55 (2003 dollars) and for overnight trips as $75 per party per trip.

Table 3C12-14. National Forest Visitor Spending Profiles by Trip Type and Spending Category, $ per party per trip (2003 dollars)

Spending Category	Non-Local Visitor			Local Visitor		
	Day Trip	Overnight Trip on NF	Overnight Trip off NF	Day Trip	Overnight Trip on NF	Overnight Trip off NF
Lodging	$ 0	$ 25.3	$ 64.9	$ 0	$ 16.2	$ 17.6
Restaurant	13.6	25.3	58.9	6.1	13.6	21.5
Groceries	7.6	36.5	31.3	5.4	41.1	23.5
Gas and Oil	16	37.3	35.8	11.7	27.7	25.9
Other Transportation	1	3	7.5	0.2	0.2	1
Activities	3.9	8	15.5	1.8	3.8	6.8
Admissions/Fees	5.2	10.2	9	3.42	10.5	8.4
Souvenirs/Other	4.3	15.6	22.4	4.2	11.2	11.4
Total	51.6	161.2	245.3	32.8	124.3	116.1

Table 3C12-15. Spending Averages by Primary Activities and Trip Type, $ per party per trip (2003 dollars)

Primary Activity	Non-Local Visitor			Local Visitor		
	Day Trip	Overnight Trip on NF	Overnight Trip off NF	Day Trip	Overnight Trip on NF	Overnight Trip off NF
Biking			343	20		
Developed Camping		140	146		128	127
Driving	40		166	24		
Fishing	42	205	238	33	125	148
General Relaxing	46	158	245	33	125	148
Hiking	37	147	276	20	79	83
Hunting	44	201	250	51	174	130
Multiple Activities			173	36		
OHV Use	62	147	182	38		
Picnic	59			38		
Primitive Camping/Backpacking		105	104			
Viewing	52	213	225	27		134

Federal Receipts

Federal income generated by activities on the GWNF is displayed in Table 3C12-16. These receipts are used to calculate the federal payments to states. Recreation user fees on this forest are under the Federal Lands Recreation Enhancement Act (sunset date 2014), which means that the majority of those receipts are returned directly back to the site of collection to enhance visitor services and reduce the backlog of maintenance needs for recreation facilities. K-V Revenue includes collections under the Knutson-Vandenberg (K-V) Act of June 9, 1930, as amended (16 U.S.C. 576-576b). The K-V Act authorizes collections from timber sale purchasers for sale area improvement work, including reforestation and wildlife habitat improvements. Specified Road Costs are, generally, credits, deposits or adjustments to payments by purchasers of timber sale contracts.

Table 3C12-16. Federal Receipts from Resource Programs on the GWNF

Source	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Class 1 - Timber	$153,403	$233,606	$153,642	$15,136	$123,010
Class 2 - Grazing in East	$3,233	$2,335	$2,842	$3,113	$3,010
Class 3 - Land Use	$52,134	$37,655	$96,477	$98,974	$79,991
Class 4 - Recreation Special Uses	0	0	0	0	0
Class 5 - Power	$22,273	$18,429	$45,631	$72,611	$70,843
Class 6 - Minerals	$1,690	$1,495	$2,180	$1,575	$1,355
Class 7 - Recreation User Fees	$665,457	$717,703	$748,671	$754,940	$705,313
Class 8 - Grazing in West	0	0	0	0	0
Class 9 - Quartz Crystals	0	0	0	0	0
Total NFF Receipts	$232,732	$293,519	$300,774	$191,410	$279,210
K-V	$645,563	$481,780	$329,698	$329,448	$363,078
Specified Road Credits	$86,377	$142,874	$-10,474	$16,948	$46,528
Salvage Sales	$179,792	$273,634	$377,155	$101,538	$65,779
Total	$1,809,922	$1,909,511	$1,745,822	$1,394,283	$1,458,907

Federal Payments

Counties receive two types of payments when federal lands are located within their boundaries. The first of these is Payment in Lieu of Taxes (PILT). These payments are from federal to local governments to help offset losses in property taxes due to nontaxable federal lands within their boundaries. The amount of PILT is based on population, receipt sharing payments, and the amount of federal land within an affected county. The second payment is based on revenue-producing activities (such as timber harvest, mineral extraction, special use permits) on NFS lands to compensate for loss of property tax revenue. The Secure Rural Schools and Community Self-Determination Act of 2000 (Public Law 106-393), was enacted to provide five years of transitional assistance to rural counties affected by the decline in revenue from timber harvests on federal lands. The last payment authorized under P.L. 106-393 was for FY 2006; however, the Act was amended and reauthorized in 2008 until 2011 and then reauthorized for FY 2012. The Act gives Counties the option of receiving payments based on either: the Twenty-Five Percent Fund (25% of receipts from NFS revenue-producing activities generated within that County); or a funding amount that is based on several factors, including acreage of Federal land, previous payments, and per capita personal income. These funds can be used for improvements to public schools, roads, stewardship projects, watershed and ecosystem improvements, community protection and strengthening of local economies. Tables 3C12-17 and 3C12-18 highlight the payments made under PILT and the Secure Rural Schools and Community Self-Determination Act for the last several years.

Table 3C12-17. Payment in Lieu of Taxes (PILT) from the GWNF

County, State	2007	2008	2009	2010	2011
Alleghany, VA	$150,295	$240,286	$243,345	$117,845	$143,777
Amherst, VA	$47,645	$76,239	$76,962	$22,143	$33,219
Augusta, VA	$223,709	$357,462	$362,266	$209,588	$242,672
Bath, VA	$184,200	$290,482	$278,208	$224,452	$233,204
Botetourt, VA*	$88,667	$144,705	$149,664	$109,494	$132,828
Frederick, VA	$5,173	$8,267	$8,369	$8,423	$9,123
Highland, VA	$56,551	$90,471	$91,526	$37,060	$43,892
Nelson, VA	$28,120	$44,864	$45,536	$52,794	$53,562
Page, VA	$84,901	$133,786	$136,452	$96,251	$103,788
Rockbridge, VA*	$71,583	$115,597	$118,056	$69,637	$82,085
Rockingham, VA	$200,716	$320,280	$325,269	$380,881	$386,367
Shenandoah, VA	$79,820	$127,621	$129,232	$158,435	$161,009
Warren, VA	$29,109	$46,973	$46,205	$48,880	$49,385
Hampshire, WV	$5,076	$8,056	$8,247	$8,435	$8,505
Hardy, WV	$75,002	$119,032	$121,849	$124,629	$125,658
Monroe, WV*	$29,198	$46,337	$47,433	$48,515	$48,915
Pendleton, WV**	$123,500	$196,519	$205,174	$151,471	$177,457
Virginia Counties from NF system lands	$1,250,489	$1,997,033	$2,011,090	$1,535,883	$1,674,911
West Virginia Counties from NF system lands	$232,776	$369,944	$382,703	$333,050	$360,535
TOTAL	$1,483,265	$2,366,977	$2,393,793	$1,868,933	$2,035,446

* - includes Jefferson NF
** - includes Monongahela NF
Source: USDI, http://www.doi.gov/pilt/

Table 3C12-18. Payments to States under the Secure Rural Schools and Community Self-Determination Act from GWNF (does not include other national forest lands within the same county)

County	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011
Alleghany, VA	$83,974	$221,404	$198,907	$173,543	$155,700
Amherst, VA	$34,000	$93,181	$83,409	$74,271	$69,413
Augusta, VA	$115,383	$285,132	$257,013	$236,210	$217,711
Bath, VA	$103,078	$170,539	$154,841	$134,025	$121,495
Botetourt, VA	$7,219	$13,490	$11,308	$9,714	$8,936
Frederick, VA	$2,914	$5,843	$5,262	$4,944	$4,510
Highland, VA	$34,323	$93,504	$87,986	$77,813	$70,723
Nelson, VA	$11,117	$5,760	$5,566	$5,176	$4,812
Page, VA	$16,082	$60,635	$54,515	$47,848	$43,215
Rockbridge, VA	$26,433	$61,334	$55,699	$48,909	$44,212
Rockingham, VA	$82,679	$40,614	$39,244	$36,493	$33,929
Shenandoah, VA	$45,009	$22,089	$21,352	$19,856	$18,461
Warren, VA	$1,689	$1,827	$1,766	$1,642	$1,527
Hampshire, WV	$2,159	$9,219	$8,716	$8,112	$7,571
Hardy, WV	$34,431	$104,740	$99,594	$95,980	$87,568
Monroe, WV	$273	$1,146	$1,121	$983	$862
Pendleton, WV	$78,998	$120,299	$108,231	$75,753	$82,321
Virginia Counties from NF system lands	$563,900	$1,075,352	$935,858	$870,444	$794,644
West Virginia Counties from NF system lands	$115,861	$235,404	$217,662	$180,828	$178,322
TOTAL	$679,761	$1,310,756	$1,153,520	$1,051,272	$972,966

Source: US Forest Service All Service Receipts (ASR-10-02) Reports

DIRECT, INDIRECT AND CUMULATIVE SOCIAL ENVIRONMENT EFFECTS

The most important effect related to the social environment is the continuing increase in population in many Virginia counties within close proximity of the George Washington National Forest. Most of the areas with the greatest population growth (over 25%) either contain NFS lands or are within a short travel time from the Forest. Many people move to these areas to be within commuting distance of employment opportunities in urban/metro areas such as Northern Virginia, Richmond and the coastal region of Virginia, while still living in a more rural setting. As the more rural communities become more populated, social expectations of residents related to Forest management can change. Long-term residents of rural communities generally value the natural scenery and quality of life more highly than the conveniences that increased development in community services can bring.

The effects of this population growth are likely most felt in the demand for, and use of, a variety of recreation opportunities on the Forest. In addition to population growth, another social factor that affects the recreation experience is the increasing average age of the population. Therefore the need for some recreationists to have remote settings to escape an increasing population may need to be balanced with the need for more

accessible settings for older recreationists. The alternatives developed for the EIS address the different types of recreation in various ways and those effects are discussed in more detail within the Recreation section of the EIS. In general, Alternative C, and to a lesser extent Alternative F, is more favorable for those recreationists seeking a more remote experience, because of the decreased amount of roads, increase in Recommended Wilderness Study areas and decreased amount of timber harvest. However, motorized access to more areas of the national forest increases the satisfaction of visitors who hunt, fish, photograph scenery, birdwatch, pick berries, disperse camp or drive for pleasure. The roads themselves are often enjoyed by people with limited mobility and/or limited time.

Developed recreation does not vary significantly by alternative. In all alternatives there will be an emphasis to upgrade the accessibility of existing and expanded sites, which are considered high priority improvements. None of the alternatives will meet the local market demand for developed recreation. The effects of unmet demand will be greatest with Alternatives C and E, followed closely by Alternatives A, B, D, G, H and I. Alternative F meets more of the developed recreation demand than the others, but this will diminish with time as the population increases while the amount of public lands offering these opportunities remain fairly static. Some sites could become increasingly overused and crowded. Initially this may occur only at peak times such as holidays and weekends; but over time this could extend to much of the primary recreation season from Memorial Day to Labor Day. This could result in lower satisfaction levels and some visitors could have unmet expectations. Some could seek the supply of developed recreation on state, county and private lands.

The biggest effect for non-motorized recreation is with the miles of trail currently open to mountain bicycles that would be closed to that use if Recommended Wilderness Study areas are designated by Congress as Wilderness. Alternatives C and F allocate the most acres to Recommended Wilderness Study. This would also have a lesser effect on horseback use on trails in these areas. Although horses are allowed in Wilderness, it can become more difficult to maintain those trails for horseback use without the use of mechanized equipment.

Other effects from an increasing population include: impacts on native fish and wildlife habitats and populations; greater opportunities for the spread of non-native invasive species, impacts on recreation access, management and quality of recreation experiences; impacts on fire management and suppression; impacts on water quality and hydrology; increases in special use permit requests, and impacts on law enforcement.

The impacts to the social environment related to federal oil and gas leasing are discussed in Chapter 3, Section D.

DIRECT, INDIRECT AND CUMULATIVE ECONOMIC ENVIRONMENT EFFECTS

The management of the George Washington National Forest has the potential to affect jobs and income within its area of influence. The Forest Service uses IMPLAN (impact for planning analysis) software and FEAST (forest economic analysis spreadsheet tool) to estimate these impacts and contributions. IMPLAN is an economic model originally developed by the Forest Service, Federal Emergency Management Agency and the Bureau of Land Management. IMPLAN has since been privatized and is now provided by Minnesota IMPLAN Group (MIG). IMPLAN uses a database of economic statistics obtained from major government sources such as the Regional Economic Information System (REIS), Bureau of Economic Analysis, Bureau of Labor Statistics and US Census Bureau. The database in IMPLAN represents 528 economic sub-sectors. The input/output analysis is based on the interdependencies of the production and consumption elements of the economy within an impact area. Industries purchase from primary sources (raw materials) and other industries (manufactured goods) for use in their production process. These outputs are sold either to other industries for use in their production process or to final consumers. The structure of interdependencies between the individual sectors of the economy forms the basis of the input/output model. The flow of industrial inputs can be traced through the input/output accounts of the IMPLAN model to show the linkages in the impact area economy. This allows the determination of estimated economic effects (in terms of employment and income).

The IMPLAN model identifies direct, indirect and induced effects associated with an output activity. Direct effects are those economic effects associated with economic activity (e.g., amount of sawtimber sold or recreation use) that occurs in industries tied to forest outputs. Examples of direct industries are the local hotel,

which provides lodging to recreationists or the local sawmill that processes National Forest timber. Indirect effects are economic effects associated with spending by industries that provide goods and services to the direct industries. An example is the utility company that provides electricity to the local hotel or sawmill. Induced effects are economic effects associated with household spending caused by changes in activity in the direct and indirect industries. Examples are the local grocery stores and restaurants that supply goods and services to the local economy.

Direct, indirect and induced impacts on jobs and income are estimated from six major Forest-level outputs on the GWNF: recreation use, hunting and fishing use, the amount of timber volume and type of product to be harvested, mineral extraction, payments to states (counties), and Forest Service expenditures (salaries, equipment, contracts). Due to substitution effects from competing non-government sources (such as volume of timber harvesting which may occur on private lands if national forest timber is not offered to the market to meet local demand), these jobs are characterized as being associated with local economic activity initiated by Forest Service programs and activities, rather than directly caused by these activities.

For purposes of estimating the economic impact, the counties and their independent cities that contain GWNF acreage were selected as the impact area. The most important use of the results is to compare relative economic effects among the alternatives. The results should not be viewed as absolute economic values that accurately portray the infinitely complex economic interactions of the regional economy.

Cumulative economic effects related to the GWNF's resource management programs are difficult to predict. Most of the variables shaping the economic environment are beyond the control of the Forest Service. Other industries (states, counties, private landowners, and private industry) also play important roles in providing jobs and income within the 17 counties.

Employment

Tables 3C12-19 and 3C12-20 illustrate how the proposed resource activities for each alternative potentially affects jobs in the local economy for the GWNF. In the IMPLAN model, jobs can be part-time, full-time or seasonal. The estimates from the Minerals Program do not include the effects from development of Marcellus shale. Those estimates are provided in Chapter 3, Section D.

Overall, the current management of the George Washington National Forest influences a very small part of the area's economy with respect to total jobs (584 jobs, 0.27%). Therefore, the differences between alternatives would not generate a noticeable effect. However, there is a number of small logging companies that could be individually affected by the changes in timber outputs associated with each alternative. There are several counties where timber-related jobs represent more than 10% of that county's total employment (Alleghany, Highland, Rockbridge and Hardy).

Of the jobs that forest activities do influence, the money spent by the GWNF on salaries, contracts, materials, equipment and other items has the greatest impact (over 50%). Recreation, including hunting and fishing, comprises another 20% of jobs affected. There are several counties where the travel and tourism employment is greater than 10% of that county's total employment (Alleghany, Augusta, Bath, Highland, Page, Rockbridge, Rockingham, Warren, and Hampshire).

Table 3C12-19. Employment by Program by Alternative (Average Annual, Decade 1, jobs contributed)

Resource	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Recreation[1]	78	79	67	83	74	83	80	80
Wildlife and Fish[1]	52	53	44	55	49	55	54	54
Timber	88	106	0	199	60	38	106	110
Minerals[2]	0	0	0	0	0	0	0	0
Payments to States/Counties	64	64	64	64	64	64	64	64
Forest Service Expenditures	351	321	299	332	318	314	322	322
Total Forest Service Mgt	633	623	474	733	565	554	626	630

[1] Recreation and Wildlife and Fish estimates represent non-local use only.
[2] The employment estimates from the GWNF that include the effects of developing Marcellus shale are provided in Chapter 3, Section D.

Table 3C12-20. Employment by Major Industry by Alternative (Average Annual, Decade 1, jobs contributed)

Industry	Local Economy Total	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Agriculture	10,972	65	74	5	123	44	31	74	75
Mining[1]	857	1	1	1	1	1	1	1	1
Utilities	624	1	1	1	1	1	1	1	1
Construction	18,967	6	6	5	6	5	5	6	6
Manufacturing	31,775	11	14	2	33	8	6	14	15
Wholesale Trade	5,497	12	11	8	13	10	11	12	12
Transportation & Warehousing	11,289	12	12	8	14	10	10	12	12
Retail Trade	20,129	64	58	44	65	53	55	58	59
Information	1,842	2	2	2	2	2	2	2	2
Finance & Insurance	7,367	9	8	6	10	8	7	8	8
Real Estate & Rental & Leasing	7,834	13	12	8	14	11	10	12	12
Prof, Scientific, & Tech Services	7,282	13	11	8	13	10	10	11	11
Mngt of Companies	1,404	1	1	0	1	0	0	1	1
Admin, Waste Mngt & Rem Serv	8,796	10	10	7	12	9	9	10	10
Educational Services	3,270	3	3	2	4	2	2	3	3
Health Care & Social Assistance	17,102	26	22	14	28	20	19	22	23
Arts, Entertainment, & Rec	3,587	23	22	18	24	21	23	23	23
Accommodation & Food Services	14,430	65	62	50	68	58	62	63	63
Other Services	11,892	13	12	7	16	11	10	12	12
Government	32,337	284	282	279	283	281	281	282	282
Total	217,252	633	623	474	733	565	554	626	630

[1] The employment estimates from the GWNF that include the effects of developing Marcellus shale are provided in Chapter 3, Section D.

Labor Income

Labor income is employee compensation (value of all wages and benefits) plus the income to sole proprietorships. The average annual labor income for the first decade for each resource program expenditure is given by alternatives in Table 3C12-21. Impacts to the local economy industries are shown in Table 3C12-22. For a description of the industrial sectors, see the Chapter 3, Section C Economic Affected Environment section.

As with employment, the current management of the George Washington National Forest influences a very small part of the area's economy with respect to total labor income ($17,796,000, 0.21%). Therefore, the differences between alternatives would not generate a noticeable effect. However, within several industries, there is a greater influence. Within the Agriculture, Forestry, Fishing and Hunting industry, Alternatives A, B, E, F, G, H and I provide activities from the timber program, hunting and fishing that contribute to about 2% of the total labor income for that particular industry. Since there is no timber program in Alternative C, there would be less than 1% contribution to labor income. Alternative D raises the income to 4% of the total labor income for that industry because of the higher volume of wood products generated. The Arts, Entertainment and Recreation industry and the Government and Public Administration industry each have about 1% of their total labor income from GWNF activities.

Table 3C12-21. Labor Income by Program by Alternative (Average Annual, Decade 1, thousands of 2012 dollars)

Resource	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Recreation[1]	$2,030	$2,061	$1,754	$2,173	$1,945	$2,169	$2,104	$2,105
Wildlife and Fish[1]	$1,417	$1,439	$1,204	$1,515	$1,351	$1,512	$1,468	$1,468
Timber	$2,426	$3,011	$0	$5,845	$1,674	$1,049	$3,011	$3,114
Minerals[2]	$12	$9	$1	$9	$8	$7	$8	$8
Payments to States/Counties	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593
Forest Service Expenditures	$16,544	$12,058	$8,793	$13,608	$11,540	$11,010	$12,123	$12,126
Total Forest Management	$25,021	$21,171	$14,345	$25,743	$19,111	$18,339	$21,308	$21,416

[1] Recreation and Wildlife and Fish estimates represent non-local use only.
[2] The income estimates from the GWNF that include the effects of developing Marcellus shale are provided in Chapter 3, Section D.

Table 3C12-22. Labor Income by Major Industry by Alternative (Average Annual, Decade 1, thousands of 2012 dollars)

Industry	Local Economy Total	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Agriculture	$80,850	$1,678	$1,941	$82	$3,287	$1,143	$777	$1,941	$1,979
Mining	$38,630	$23	$21	$15	$21	$21	$20	$21	$21
Utilities	$94,102	$143	$127	$93	$156	$116	$113	$128	$129
Construction	$672,359	$206	$191	$161	$216	$182	$179	$192	$193
Manufacturing	$1,811,431	$506	$687	$108	$1,577	$409	$277	$688	$730
Wholesale Trade	$318,870	$668	$632	$478	$729	$578	$602	$640	$643
Transportation & Warehousing	$583,277	$501	$477	$329	$596	$423	$424	$482	$486
Retail Trade	$554,733	$1,619	$1,454	$1,126	$1,626	$1,356	$1,405	$1,473	$1,476

Industry	Local Economy Total	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Information	$99,742	$103	$96	$76	$111	$89	$89	$97	$98
Finance & Insurance	$301,333	$356	$323	$237	$385	$294	$287	$325	$326
Real Estate & Rental & Leasing	$95,068	$176	$158	$124	$180	$147	$145	$158	$159
Prof, Scientific, & Tech Services	$313,297	$540	$450	$344	$515	$423	$412	$452	$453
Mngt of Companies	$96,587	$38	$38	$25	$50	$33	$32	$38	$38
Admin, Waste Mngt & Rem Serv	$199,359	$222	$209	$164	$244	$193	$192	$210	$211
Educational Services	$110,361	$101	$86	$60	$104	$78	$75	$87	$87
Health Care & Social Assistance	$693,082	$992	$831	$576	$998	$757	$727	$836	$840
Arts, Entertainment, and Rec	$44,490	$303	$300	$248	$322	$281	$308	$306	$306
Accommod-ation & Food Services	$255,180	$1,070	$1,025	$832	$1,117	$960	$1,032	$1,042	$1,044
Other Services	$380,415	$398	$357	$239	$443	$316	$303	$359	$361
Government	$1,739,943	$11,768	$11,768	$9,031	$13,066	$11,310	$10,939	$11,832	$11,835
Total Forest Management	$8,483,108	$25,021	$21,171	$14,345	$25,743	$19,111	$18,339	$21,308	$21,416

[1] The income estimates from the GWNF that include the effects of developing Marcellus shale are provided in Chapter 3, Section D.

Budget to Implement the Forest Plan

Table 3C12-23 displays the expected annual appropriated budget needed to implement each alternative. These figures do not include additional funds from special projects, grants, agreements, trust funds (like Knutson/Vandenberg funds or Roads and Trails funds), or federal highway funds. Alternatives G, H and I were modeled at a level of timber harvest of 54 MMCF and a level of prescribed burning of 16,000 acres. If these Alternatives are modeled at the low end of the range for prescribed fire (12,000 acres), the total budget would be $228 M$ less. If these alternatives are modeled at the high end of the range for prescribed fire (20,000 acres), the total budget would be $228 M$ more. If these alternatives are modeled at the low end of the range for timber harvest (31 MMCF), the total budget would be reduced by $920 M$.

Table 3C12-23. Annual Budget to Implement the Forest Plan

Program Area	Program Costs (thousand dollars, annual average cost)								
	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Cost Pools (Administration)	$1,900	$1,912	$1,900	$1,900	$1,900	$1,900	$1,900	$1,900	$1,900
Timber	$2,270	$889	$2,769	$0	$4,289	$1,849	$1,409	$2,769	$2,769
Roads/Engineering	$3,045	$1,612	$1,839	$1,632	$1,949	$1,812	$1,764	$1,839	$1,839
Recreation	$6,269	$3,200	$3,631	$3,700	$4,208	$3,631	$3,807	$3,702	$3,705
Wildlife	$1,573	$457	$637	$382	$700	$637	$637	$637	$637
Soil, Water, Air & Veg Mgmt	$1,581	$292	$709	$709	$709	$735	$709	$735	$735
Fire	$1,114	$1,740	$1,955	$1,214	$1,527	$2,183	$1,955	$1,955	$1,955
Lands	$1,537	$251	$427	$427	$427	$427	$427	$427	$427
Range	$10	$10	$10	$10	$10	$10	$10	$10	$10
Minerals	$218	$220	$209	$190	$228	$190	$209	$190	$190
Planning, Inventory, Monitoring	$358	$611	$400	$400	$400	$490	$400	$400	$400
Total Appropriated Budget	$19,874	$11,194	$14,485	$10,564	$16,347	$13,863	$13,226	$14,564	$14,567

A[1] represents the actual implementation level of the 1993 Revised GWNF Plan

Economic Efficiency

Present net value (PNV) is the measure used to calculate the economic efficiency of managing a national forest. When discussing the evaluation of Forest Plan alternatives, the regulations state that the evaluation 'shall compare present net value, social and economic impacts, outputs of goods and services, and overall protection and enhancement of environmental resources' [36 CFR 219.12(h)]. Present net value is defined as 'the difference between the disputed value (benefits) of all outputs to which monetary values or established market prices are assigned and the total discounted costs of managing the planning area' [36 CFR 219.3] and is the primary criteria used to measure the financial efficiency of the different resource management programs. The analyzed benefits include market values, where the Forest Service receives money for timber, range, special uses, etc., and non-market values. Non-market values can be assigned for activities such as wildlife viewing and recreation.

There are many values associated with National Forests that cannot be expressed in monetary terms. Many values are highly personal and subjective in nature. These, however, may be the greatest value of National Forests to the nation. The regulations state that plans 'shall provide for multiple use and sustained yield of goods and services from the National Forest System in a way that maximizes long-term net public benefits in an environmentally sound manner' [36 CFR 219.1]. The NFMA regulations define net public benefits as: 'An expression used to signify the overall long-term value to the nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be quantitatively valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than a single measure or index' [36 CFR 219.3]. Because not all values are expressed in monetary terms and therefore not included in the financial efficiency analysis does not mean that they have been excluded from the determination of 'net public benefits.' For those resources that can be reasonably valued via market data (e.g. timber, minerals and range) and for those non-market resources that have Forest Service estimated values from research (recreation and wildlife), we have presented values in the present net value calculations. (See also Appendix B for more information on calculating the present net values). For resources that have no values estimated by generally accepted methods, we will discuss them in a narrative fashion as part of the assessment of net public benefits that is made in the Record of Decision for the George Washington National Forest Plan.

Revenues and costs were calculated for various resource management activities for all alternatives. Recreation values were calculated from Forest Service National Visitor Use Monitoring estimates for the GWNF.

Timber sale revenue was calculated based on historic GWNF timber sale bid values and estimates of volume. Minerals revenue was based on a 15 year average (March 1997-Feb 2012) using U.S. Energy Information Administration (2012) data for natural gas. Costs were developed based on each resource area's budgeted costs estimated for each alternative. Costs and revenues were estimated for five decades of plan implementation and discounted to present values. The present net value of these revenues and costs are displayed in the table below for each alternative as decadal totals.

The cumulative total present net values between all of the alternatives are fairly close together. Although some program emphases change between alternatives, both the costs and benefits change at a proportional rate, making the net PNV more comparable.

The recreation and timber programs generate the majority of the federal receipts. At the current time, recreation fees are returned directly to the Forest. The cumulative PNV for the timber sale program ranges from -$19,136 in Alternative A to $39,294 in Alternative D. The Knutson-Vanderberg Act (K-V) collection from timber sales allows additional timber stand improvement work and wildlife habitat improvements to be accomplished on the Forest.

Table 3C12-24. Cumulative Decadal Present Net Values of Benefits and Costs (millions of dollars, 4% discount rate cumulative to midpoint of 5th decade)

Resource Program	Alt A	Alt A[1]	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Present Value Benefits by Program:									
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$36	$17	$71	$0	$145	$36	$21	$62	$67
Minerals[1]	$1	$<1	$1	$<1	$1	$1	$1	$1	$1
Recreation	$1,162	$1,162	$1,181	$1,007	$1,242	$1,111	$1,244	$1,205	$1,206
Wildlife	$661	$661	$668	$562	$713	$640	$698	$684	$684
Total Present Value Benefits	$1,860	$1,842	$1,921	$1,569	$2,101	$1,788	$1,964	$1,952	$1,958
Present Value Costs by Program:									
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$55	$23	$69	$0	$106	$47	$36	$69	$69
Roads/Engineering	$73	$80	$46	$43	$48	$46	$45	$46	$46
Minerals	$5	$5	$5	$4	$6	$5	$5	$5	$5
Recreation	$151	$84	$91	$99	$107	$91	$97	$93	$93
Wildlife	$38	$12	$16	$10	$17	$16	$16	$16	$16
Soil, Water and Air	$38	$8	$18	$19	$17	$18	$18	$18	$18
Protection/Forest Health	$27	$46	$49	$32	$38	$55	$50	$49	$49
Lands	$37	$7	$11	$11	$10	$11	$11	$11	$11
Planning, Inventory, Monitoring	$9	$16	$10	$11	$10	$12	$10	$10	$10
Total Present Value Costs	$433	$281	$315	$230	$356	$302	$288	$317	$317
Cumulative Total Present Net Value	$1,427	$1,561	$1,606	$1,339	$1,745	$1,486	$1,676	$1,635	$1,641

[1] The present net value calculations for the GWNF that include the effects of developing Marcellus shale are provided in Chapter 3, Section D.

Environmental Justice and Civil Rights

A specific consideration of equity and fairness in resource decision-making is encompassed in the issues of environmental justice and civil rights. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Principles for considering environmental justice are outlined in Environmental Justice Guidance under the National Environmental Policy Act (Council on Environmental Quality (CEQ) 1997). The Executive Order makes clear that its provisions also apply fully to programs involving Native Americans. The Executive Order contains emphasis on the potential effects of agency actions on subsistence consumption of fish, vegetation or wildlife. The Executive Order also requires agencies to work to ensure effective public participation and access to information.

To fulfill these principles, environmental justice was considered throughout the land management planning process in the following phases:

1. Scoping and Public Participation – Efforts were made by the forest to reach as many people in the area as possible, through mailings, newspaper articles, news releases, radio interviews and contacts with federal, state and local governments, churches, libraries, non-profit organizations, civic associations, industries, academia, and other types of organizations. Participation was sought in various locations and formats throughout the planning area.

2. Determining the Affected Environment – The Social and Economic Environment section of Chapter 3 of the EIS presented information related to population growth, minority populations, population density, income, unemployment and poverty, households, and economic diversity in the area directly affected by George Washington National Forest management and compared this information within a more regional context when appropriate. There were no segments of the population identified that depend on subsistence consumption of fish, wildlife or vegetation within the planning area. No areas were identified that had significant minority populations, high poverty and unemployment rates, negative population growth, or depressed housing values.

C13 – WIND ENERGY DEVELOPMENT

Wind energy is renewable and can reduce the use of fuels generating carbon gases and positively affect climate change. Wind energy development is a priority for Federal agencies. The Forest Service is the only federal agency in the east that can accommodate wind development within its multiple-use mission and has the land base to accommodate this development.

AFFECTED ENVIRONMENT

Nationally, the best areas for wind energy are the plains and the coast. The U.S. Department of Energy has identified many of the ridges on the Forest as potentially able to support wind energy production (Figure 3C13-1). About 117,000 acres of the Forest are identified on this map as having Class 3 (Fair) or higher ratings for wind resource potential. The USDA Forest Service and National Renewable Energy Laboratory (2005) identified 35,810 acres of the GWNF with a high potential for wind area development. The GWNF is in close proximity to growing population centers that would benefit from additional and clean energy production.

Wind energy development has not occurred on the Forest. A project is under construction in Highland County adjacent to the GWNF.

Alternative A. This is an emerging issue. Ridgeline development associated with wind energy development is not discussed in the George Washington 1993 Forest Plan. Basically, the special use process would be used to consider any applications for wind energy development. No areas are considered to be unsuitable for wind energy development (except for wilderness and recommended wilderness), though management area guidance would limit road construction and clearing activities in some areas.

Alternatives B, D, F, G, H and I would allow consideration of wind energy development proposals on some areas of the Forest. Proposals for development would be evaluated and if accepted, would be analyzed through the NEPA process. The following areas are unsuitable for wind energy development under Alternatives B, F, G, H and I:

- Wilderness
- Recommended Wilderness Study Areas
- Eligible Scenic River Corridors
- Eligible Recreation River Corridors
- Appalachian Trail Corridor
- Research Natural Areas
- Geologic Areas
- Special Biological Areas
- Key Natural Heritage Community Areas
- Cultural Areas
- Mount Pleasant National Scenic Area
- Recommended National Scenic Areas
- Scenic Corridors and Viewsheds (Alts H and I only)
- Developed Recreation Areas
- Blue Ridge Parkway Scenic Corridor
- Shenandoah Mountain Crest – Cow Knob Salamander Area
- Indiana Bat Protection Areas
- Remote Backcountry Areas

Alternative D is similar to Alternatives B, F, G, H and I except that wind energy development proposals would be considered in several remote backcountry areas. The areas identified as unsuitable contain many of the ridges with high potential for wind energy development. To increase the availability of high potential sites, this alternative removes the ridgelines from some of the remote backcountry areas from the list of unsuitable areas for wind development. Wind energy development proposals could be considered in the following remote backcountry areas: Little Alleghany, Oliver Mountain, Elliott Knob, Crawford Knob, Northern Massanutten, Beech Lick Knob and Church Mountain. Aside from wind energy development proposals (including associated road and transmission line access); these backcountry areas would be managed like the other remote backcountry areas.

Alternatives C and E prohibit the development of wind energy across the GWNF.

DIRECT, INDIRECT AND CUMULATIVE EFFECTS

A total of about 117,000 acres of land on the GWNF has been identified as having fair (Class 3) to outstanding (Class 6) wind power potential (see Figure 3C13-1). Table 3C13-1 displays the amount of land identified as Class 3 or above that would be unsuitable for wind energy development under each alternative.

Table 3C13-1. Acres of Land in Wind Class 3 or Greater that is Unsuitable for Wind Energy Development

Metric	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alts H and I
Total Acres in Class 3 or Greater	117,000	117,000	117,000	117,000	117,000	117,000	117,000	117,000
Total Acres Unsuitable for Wind Energy Development	8,000	70,000	117,000	53,000	117,000	76,000	78,000	82,000

Alternative A allows for the most potential to develop wind energy, since it contains no direction regarding this development. Of the alternatives that address wind energy, Alternative D provides for the most opportunities for development. Alternatives C and E provide no opportunities for development.

For purposes of analysis, the following assumptions were made regarding possible wind energy development.

Table 3C13-2. Potential Wind Energy Development

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Sites, #		1		3		1	1
Turbines, #		15		45		15	15
Openings, acres		57		172		57	57
Transmission, miles		1		3		1	1
Road Construction, miles		1.8		5.5		1.8	1.8
Road Improvement, miles		3		9		3	3

Alternatives C, and E would have no wind energy development. They would not address the need for alternative energy sources and they would not provide jobs, taxes and economic returns to the local communities from construction and operation of the turbines.

Effects of the development on soils, scenery, aquatic resources, geologic resources and water are addressed in those sections of the EIS.

Timber Management

In the short-term, wind development would generate wood products as sites are cleared for turbines, transmission lines, and access. Because most of the development is assumed to occur on ridgetops with poor site productivity, the vast majority of product resulting from this activity would be pulpwood. Relatively low volumes and values per acre would be realized. Table 3C13-3 provides an estimate of the acres and volume that would result from clearing for wind energy development.

Table 3C13-3. Volume (CCF) of Pulpwood and Acres Cleared that would Result from Wind Development

Activity	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alts G, H and I
Openings, acres		57		172		57	57
Transmission, miles		4		11		4	4
Road construction, miles		7		20		7	7
Total Acres Cleared		68		203		68	68
Total Volume Produced (ccf)		680		2030		680	680

In the long-term, these acres would be taken out of wood and fiber production. No future production of wood can be expected on these acres.

Wildlife and Threatened & Endangered & Sensitive Species

Potential effects on wildlife include the long-term occupation of the ridgelines with openings, roads and turbines. Ridgelines are used by many birds and bats during migrations and during resident activities. Studies have documented that wind energy facilities can cause mortality in birds and bats USFWS (USDI 2012). Generally, studies in the West have reported lower rates of bat fatalities than facilities in the East. High passage rates for birds and bats along the ridgelines in western Virginia indicate a high potential for fatalities from wind turbines.

Commercial wind power development has rapidly expanded across the Appalachians. Multiple sites have been developed in West Virginia and one site is being constructed in Virginia west of Monterey in Highland County. There is growing concern that Indiana bats and Virginia big-eared bats, plus several other rare bat species like the small-footed bat, may be threatened by the recent surge in construction and operation of wind turbines across the species' range. This potential for increasing mortality and population decline has been exacerbated by the recent establishment and rapid spread of White Nose Syndrome (WNS) throughout the eastern U.S. which has killed millions of bats and has led to the precipitous decline of many once common bat species like small brown and red bats. Bats are often killed during wind tower operations when they fly into the lower pressure area surrounding the trailing edge of spinning blades and suffer extreme barotrauma where decompression causes capillaries in the lungs to explode (Baerwald et al. 2008). Bats are most affected during periods of fall migration when they often follow ridgetops and come into contact with wind towers built along those same ridgetops. Until the fall of 2009, no known mortality of an Indiana bat had been associated with the operation of a wind turbine/farm. The first documented wind-turbine mortality event occurred during the fall migration period in 2009 at a wind farm in Benton County, Indiana. Research is now under way to develop operation or engineering guidelines to avoid and minimize take of bats and assess the magnitude of the threat. A recent study has shown that injury and death to bats (and also birds) during periods of spring and fall migrations can be reduced by 44 to 93% with an annual power loss of 1% by raising the cut-in speed for blade spin and tower operation to 11-14 mph from the current industry standard of 8-9 mph (Arnett et al. 2010). Currently this is the only proven mitigation option that will reduce bat mortality.

The Bald eagle (*Haliaeetus leucocephalus*) was delisted from federal status as Threatened by the FWS, but is considered a Sensitive Species by the Regional Forester (USDA 2007). The Bald eagle and golden eagle (*Aquila chrysaetos)* are protected by the Bald and Golden Eagle Protection Act (Eagle Act) and the Migratory Bird Treaty Act (MBTA). Neither law has take provisions as mitigation measures to protect Bald or golden eagles from a

variety of harmful actions and impacts. Bald eagles and other large raptors are known to be negatively affected by commercial wind towers (Bell and Smallwood 2010, FWS 2009). Bald eagles, golden eagles and other large raptors are vulnerable to colliding with wind tower blades, especially during spring and fall migration periods. Wind energy projects can also affect bald and golden eagles by degrading or fragmenting habitat, and by introducing new sources of disturbance (noise, construction activity, permanent changes to the landscape, barriers to movement, and increased human activity). Furthermore, both bald and golden eagles may be attracted to forest openings around wind turbines to feed, particularly if sources of carrion (large birds killed by collisions) are present. Both eagle species are increasing in population, especially during the non-breeding season, in the central Appalachians (Katzner et al. 2009). The FWS's National Bald Eagle Management Guidelines recommend siting wind turbines away from known nests, foraging areas, and communal roost sites (FWS 2007).

Non-Native Invasive Plants

Alternatives C and E would have no wind power development and would not create disturbed habitat that would promote NNIP infestations. Alternative B, F, G, H, and I would create ground disturbance from the openings created for the wind tower sites, transmission lines, and road construction. These disturbed areas would be potential sites for NNIP infestations. The roads and transmission lines could act as dispersal corridors for NNIP. Alternative D would create three times the ground disturbance over Alternatives B, F, G, H, and I. Aggressive control treatments for NNIP could mitigate the impacts of the ground disturbing activities. While control would most likely utilize mechanical methods (e.g. mowing), herbicides may also be used to control NNIP that result from disturbances related to wind power development. The potential to for treated plants to develop resistance to herbicides and non-target impacts would exist on those herbicide treated acres and are described in more detail in the vegetation section of this EIS. These impacts related to wind power development would be greatest for Alternative D, much less for Alternatives B, F, G, H, and I, and no impact for Alternatives C, and E.

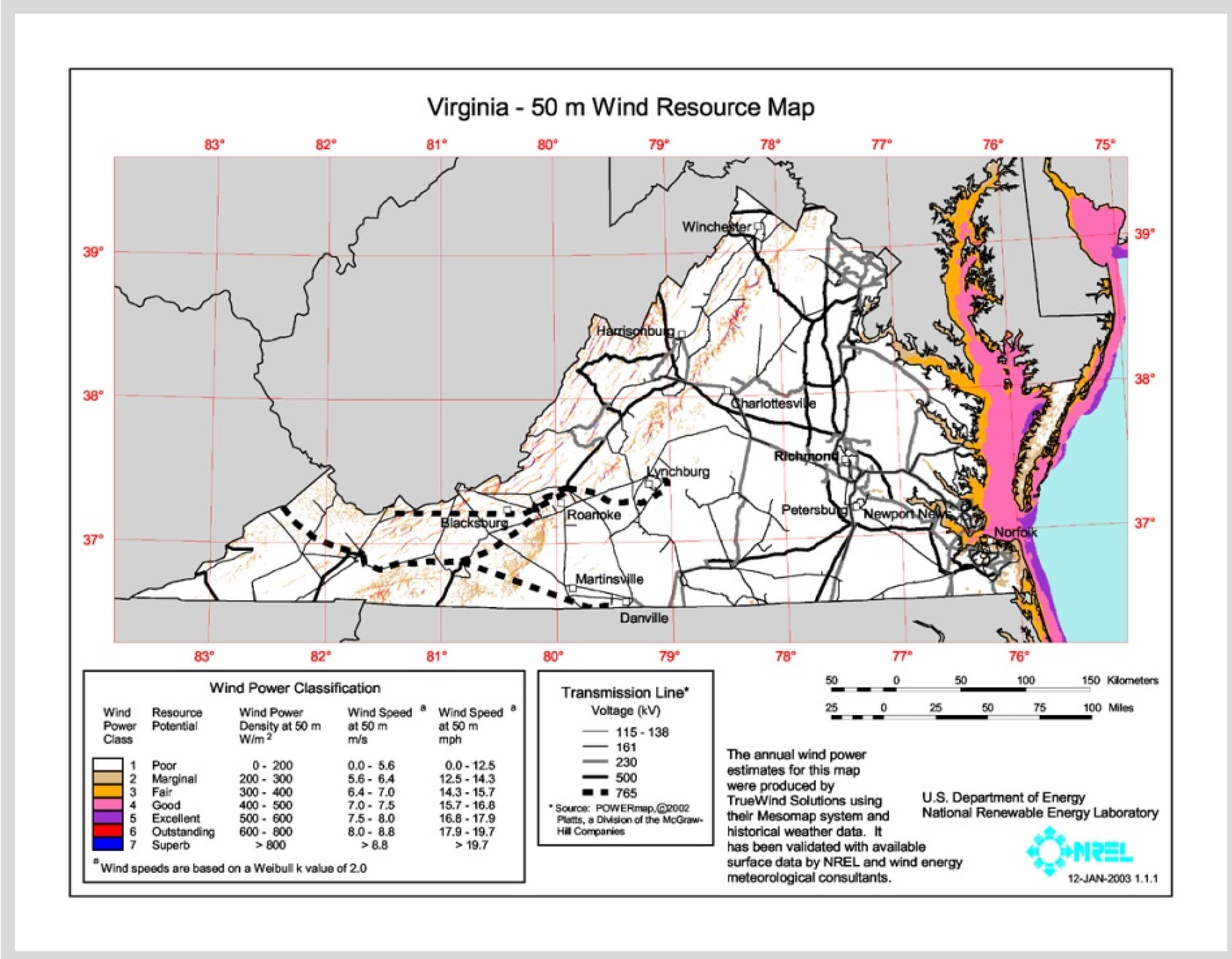

Figure 3C13-1. Virginia Wind Energy Potential

C14 - OTHER EFFECTS

Unavoidable Adverse Effects

Forest Plans do not produce unavoidable adverse effects because they do not directly implement any management activities that would result in such effects. The Forest Plans do, however, establish management emphasis and direction for implementation of activities that may occur on National Forest System lands in the planning period. If and when those activities occur, the application of Forest-wide and Management Area Prescription standards would limit the extent and duration of any resulting environmental effects. However, some unavoidable effects could still occur. These potential effects are described by resource area throughout Chapter 3 of the EIS.

Relationship of Short-Term Use and Long-Term Productivity

The relationship between the short-term uses of the environment and the maintenance and enhancement of long-term productivity is complex. Short-term uses are generally those that occur irregularly on parts of the Forest, such as prescribed burning. Long-term refers to a period greater than ten years.

Productivity is the capability of the land to provide market and amenity outputs and values for future generations. Soil and water are the primary factors of productivity and represent the relationship between short-term uses and long-term productivity. The quality of life for future generations would be determined by the capability of the land to maintain its productivity. By law, the Forest Service must ensure that land allocations and permitted activities do not significantly impair the long-term productivity of the land.

The alternatives considered in detail, including the preferred alternative, incorporate the concept of sustained yield of resource outputs while maintaining the productivity of all resources. The specific direction and mitigation measures included in the forest-wide management standards ensure that long-term productivity would not be impaired by the application of short-term management practices.

Each alternative in the Forest Plan was analyzed using the SPECTRUM linear programming model (See Appendix B – Description of the Analysis Process), to ensure that the minimum standards could be met. The alternative was changed if some aspect did not meet any of the minimum standards. Through this analysis, long-term productivity of the Forest's ecosystems is assured for all alternatives.

As stated earlier, the effects of short-term or long-term uses are extremely complex, and depend on management objectives and the resources that are emphasized. No alternative would be detrimental to the long-range productivity of the Jefferson National Forest.

The management prescriptions and the effects of implementing the revised Forest Plan will be monitored. Evaluation of the data collected will determine if standards for long-term productivity are being met, or if management practices need to be adjusted. Monitoring requirements and standards apply to all alternatives, and are included in Chapter 5 of the revised Forest Plan.

Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitments of resources are normally not made at the programmatic level of a Forest Plan. Irreversible commitments are decisions affecting non-renewable resources such as soils, minerals, plant and animal species, and cultural resources. Such commitments of resources are considered irreversible because the resource has been destroyed or removed, or the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense. While a Forest Plan can indicate the potential for such commitments, the actual commitment to develop, use, or affect non-renewable resources is normally made at the project level.

Irretrievable commitments represent resource uses or production opportunities, which are foregone or cannot be realized during the planning period. These decisions are reversible, but the production opportunities

foregone are irretrievable. An example of such commitments is the allocation of management prescriptions that do not allow timber harvests in areas containing suitable and accessible timber lands. For the period of time during which such allocations are made, the opportunity to produce timber from those areas is foregone, thus irretrievable. Examples of irretrievable resource commitments associated with project-level are:

- Opportunities for non-motorized recreation, solitude, and primitive or wilderness experiences would be foregone when projects are implemented for other purposes
- Timber volume outputs would be foregone on land determined as not suitable for harvest.
- Opportunities to maintain or produce a specific vegetation condition are foregone for some period of time so that another vegetation condition may be produced in its place, such as through silvicultural prescriptions and the use of herbicides
- Commodity outputs would be reduced or foregone on areas where specific uses are implemented, such as developed recreation areas
- Non-commodity values, including scenic resources, may be reduced or foregone in areas where commodity uses are implemented
- To the degree that an action preserves or encourages the development of mature and old-growth habitat, opportunities to develop early structural habitat would be reduced (The reverse is also true, to the degree that an action preserves or encourages the development of early structural habitat, opportunities to develop mature and old-growth habitat would be reduced.)

In the case of the Federal oil and gas leasing discussed in the minerals section of this Chapter, actual extraction of oil and gas would be considered an irreversible commitment, since this is a non-renewable resource. However, the decision to actually permit this extraction will occur following receipt of an Application for Permit to Drill.

Effects on Wetlands and Floodplains

No significant adverse impacts on wetlands or floodplains are anticipated. Wetlands values and functions would be protected in all alternatives through the implementation of the Riparian Management Prescription and following Virginia's Best Management Practices for Forestry. Under the requirements of Executive Order 11990 and Clean Water Act, Section 404, wetland protection would be provided by ensuring that new construction of roads and other facilities would not have an adverse effect on sensitive aquatic habitat or wetland functions. In addition, wetland evaluation would be required before land exchanges or issuance of special-use permits in areas where conflicts with wetland ecosystems may occur.

Mitigation measures have been designed to conserve riparian areas and protect floodplains through the Riparian Management Prescription. The direction of this prescription is embedded in all management prescriptions. Executive Order 11988 also requires site-specific analysis of floodplain values and functions for any project occurring within the 100-year floodplain zone, and prior to any land exchange involving these areas.

Protective measures for riparian areas include the delineation of riparian corridors on perennial and intermittent streams. Management activities within the riparian corridor must comply with the previously mentioned State BMPs and other State water quality regulations. Floodplains would be managed by locating critical facilities outside of floodplains or by using structural mitigation measures. Further protections are provided in forest-wide standards for management of ephemeral stream zones.

Unavailable or Incomplete Information

The George Washington National Forest has used the most current scientific information available and state-of-the-art analytical tools to evaluate management activities and to estimate their environmental effects.

However, gaps will always exist in our knowledge. The Council on Environmental Quality regulations discuss the process for evaluating incomplete and unavailable information (*40 CFR 1502.22 (a) and (b)*). Incomplete or unavailable information is noted in this chapter for each resource, where applicable.

Forest Plan monitoring is designed to evaluate assumptions and predicted effects. Should new information become available, the need to change management direction or amend the Forest Plan would be determined through the monitoring and evaluation process.

Energy Requirements and Conservation Potential

Energy is consumed in the administration of natural resources on the Forest. The main activities that consume energy are timber harvest, restoration activities including mechanical vegetation treatments and prescribed fire, recreation use, road construction and reconstruction, range use, and administrative activities of the Forest Service and other regulatory agencies. Energy consumption is displayed in Tables 3C7-1 through 3C7-4.

Several opportunities exist under all alternatives to provide for energy conservation or conversion from less plentiful fuels to more plentiful fuels. For example, car-pooling and combining trips saves fuels and wear and tear on the Forest fleet. The use of electronic communication devices for sharing information rather than scheduling meetings at one location saves energy spent on travel. Improving energy efficiency of government buildings can conserve energy. More energy-efficient equipment for all activities like timber harvesting, road construction and reconstruction, or road maintenance can be required. More energy-efficient management methods can be explored and implemented as well.

Prime Farmland, Rangeland and Forestland

No prime farmland, rangeland, or forestland has been identified in the planning area. Forest Plan revision or the Forest Plan would not directly affect such lands; although implementation of the Plan could have indirect effects. Regardless of the alternative selected for implementation, NFS lands would be managed with sensitivity to the values of any adjacent private or public lands.

Effects on the Human Environment

Effects on the human environment are documented throughout Chapter 3 of this EIS. Further documentation can be found in the project record. Effects related to Environmental Justice are found in the Social and Economic Environment section of Chapter 3.

Conflicts with Other Agency or Government Goals or Objectives

Contact, review, and public involvement with other federal and state agencies have generally indicated no irresolvable conflicts between this Forest Plan revision effort and the goals and objectives of other governmental entities.

Several County Boards of Supervisors submitted comments opposing wilderness designation in their counties. The selected alternative did include some Recommendations for Wilderness Study in those counties. Since wilderness designation is a congressional action, these counties will have future opportunities to influence a final decision.

Several County Boards of Supervisors submitted comments opposing wind energy development. Decisions on wind energy development would have a site-specific analysis and a separate decision that will be open to participation by these governments.

SECTION D – FEDERAL OIL AND GAS LEASING AVAILABILITY

INTRODUCTION

This section of the Final EIS identifies George Washington National Forest lands that could be made available for oil and gas leasing, in accordance with the Mineral Leasing Act, under various leasing alternatives. It also describes the affected environment and discusses reasonably foreseeable impacts of oil and gas activities on the environment resulting from each leasing alternative. Oil and gas leasing is identified as a significant issue in Chapter 1 of the Final EIS. Issues and concerns expressed by the public and government agencies during the public comment period for this EIS have been addressed by the analysis. Additional discussion of specific concerns with gas development is in FEIS, Appendix I-Analysis of Concerns and Risks of Horizontal Drilling and Hydraulic Fracturing.

Management of the federal leasable oil and gas resources is a shared responsibility between the Forest Service and the U.S. Department of Interior. The Bureau of Land Management (BLM) has a major role in issuing and supervising operations on licenses, permits, and leases for federal leasable minerals. BLM cannot issue oil and gas leases for lands administered by the Forest Service without consent from the Secretary of Agriculture. As the agency responsible for federal oil and gas lease issuance and administration, the BLM participated in this EIS as a cooperating agency. This analysis will be used by both agencies as the basis for making oil and gas leasing decisions under their authorities. The responsible officials of the Forest Service and BLM may release separate Records of Decision. The Forest Service decision identifies which lands will be administratively available for oil and gas leasing along with associated conditions and lease stipulations. The BLM decision determines whether oil and gas leases will be issued on the administratively available lands.

If BLM issues any leases on the lands administratively available, the leaseholder cannot construct a road, drill a well, or conduct ground disturbing operations until the federal government (Forest Service and BLM) reviews and approves plans for each proposed well, road, and associated facilities. Before ground disturbing operations can occur, the leaseholder must submit for review and approval an Application for Permit to Drill (APD) that includes a Drilling Plan and a Surface Use Plan of Operations. The Forest Service would be the lead agency and BLM a cooperating agency for environmental analysis (NEPA) for the federal decision on the APD proposed operations on NFS lands. The Forest Service decision would involve approval of the Surface Use Plan of Operations. The BLM decision would involve approval of the entire APD.

Thus, there are two stages of federal oil and gas decisions, with each stage requiring decisions by two agencies (Forest Service and BLM). The first stage is the leasing availability decision; the second stage is the Application for Permit to Drill (APD) decision. This EIS is for the leasing decision and includes environmental protection requirements and mitigating measures that would be implemented at the second stage (APD). The site-specific environmental analysis at the second stage would tier to this EIS.

LEGISLATION AND POLICY RELATING TO OIL AND GAS

The Mineral Leasing Act of 1920 (as amended)

The Mineral Leasing Act of 1920, as amended, authorizes and governs oil and gas leasing on lands with federal oil and gas rights. The primary authority and responsibility for determinations regarding leasing remains with the Secretary of the Interior and the BLM. The Act makes deposits of oil and gas on federal lands available for oil and gas leasing, unless a specific land order has been issued to close an area. The Act also mandates that oil and gas surface-disturbing activities be regulated and reclamation procedures developed for the conservation of surface resources.

The Mineral Leasing Act for Acquired Lands of 1947

The Mineral Leasing Act for Acquired Lands of 1947 states that all deposits of coal, phosphate, oil, oil shale, gas, sodium, potassium, and sulfur that are owned or may be acquired by the US and that are within lands acquired by the US may be leased by the Secretary of the Interior under the same conditions as contained in the leasing provisions of the mineral leasing laws. No mineral deposits shall be leased without the consent of the head of the executive department having jurisdiction over the lands containing the deposit and subject to such conditions as that official may prescribe.

The Mining and Minerals Policy Act of 1970

The Mining and Minerals Policy Act of 1970 indicates that the continuing policy of the federal government is to foster and encourage private enterprise in the development of economically sound and stable domestic mining and minerals industries and the orderly and economic development of domestic mineral resources.

The Energy Security Act of 1980

The Energy Security Act of 1980 directs the Secretary of Agriculture to process applications for leases and permits to explore, drill, and develop resources on National Forest System lands, notwithstanding the current status of any management plan being prepared.

The Federal Onshore Oil and Gas Leasing Reform Act of 1987

The Leasing Reform Act amended the Mineral Leasing Act of 1920. It provides the Forest Service with more input on oil and gas leasing on National Forest System lands. Under the Leasing Reform Act, Forest Service consent is required before BLM can lease National Forest System lands. Forest Service 36 CFR 228 subpart E Oil and Gas Resources regulations, issued in 1990, established 1) the process for making oil and gas leasing decisions in accordance with the Leasing Reform Act, and 2) requirements for Surface Use Plan of Operations and inspection and compliance.

Bureau of Land Management (BLM) Regulations and Forest Service Oil and Gas Regulations

BLM regulations (43 CFR Part 3100) and Forest Service regulations (36 CFR Subpart 228E) describe the procedures by which each agency will carry out its statutory responsibilities in the issuance of oil and gas leases and in subsequent operations (Application for Permit to Drill (APD)). The BLM is responsible for offering and issuing leases and for authorizing and administering subsequent operations to explore and develop oil and gas (APD: Drilling Plan and Surface Use Plan of Operations). Title 43 CFR Subpart 3160 provides regulations for onshore oil and gas operations, including, inspection and enforcement. The Forest Service regulations prescribe methods by which the Forest Service will make decisions with regard to lands administratively available for oil and gas leases and subsequent management of oil and gas operations. The Forest Service determines which National Forest System lands are available for oil and gas leasing, and the specific lands which the BLM may offer for lease; prescribes constraints, including any Stipulations, that provide reasonable protection to surface resources; approves Surface Use Plan of Operations (SUPO); and inspects and insures compliance with the surface use requirements of the leases and operating plans.

Forest Service Strategic Plan for Fiscal Years 2007-2012

The Government Performance and Results Act of 1993 requires the Forest Service to prepare a Strategic Plan at the National level. As part of Goal (2) of the Strategic Plan for Fiscal Years 2007-2012 (to Provide and Sustain Benefits to the American People), Objective 2.3 is to help meet energy resource needs. The Strategic Plan does not specify objectives specific to oil and gas leasing but provides general direction to considering opportunities for energy development and the supporting infrastructure on National Forest System lands.

The Energy Policy Act of 2005

The Energy Policy Act or 2005 directs the Secretaries of the Interior and Agriculture to improve coordination and consultation on oil and gas leasing activities, including inspection and enforcement. The Secretaries of Agriculture and Interior entered into a MOU in April 2006 (FS Agreement No. 06-SU-11132428-052). The purpose of the MOU was to satisfy requirements of the Energy Policy Act of 2005 and to establish joint BLM and Forest Service policies and procedures for managing oil and gas leasing and subsequent actions.

Onshore Oil and Gas Order Number 1

In March 2007, Onshore Oil and Gas Order Number 1, Approval of Operations, was revised (72 FR 10308) and issued as a joint rule by the Forest Service and BLM. The order provides the requirements necessary for the approval of oil and gas operations, including reclamation, on federal onshore oil and gas leases. The revised order provides requirements for processing and administering Applications for Permit to Drill which has two parts, a Drilling Plan and a Surface Use Plan of Operations. The revised rule also addresses using Master Development Plans, encourages the voluntary use of BMPs as part of Applications for Permit to Drill processing, and requires additional bonding on certain off-lease facilities.

Executive Order 13212 – Actions to Expedite Energy-Related Projects (May 18, 2001)

Executive Order 13212 states “executive departments and agencies (agencies) shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy.” Executive Order 13212 requires that: “For energy-related projects, agencies shall expedite their review of permits or take other actions as necessary to accelerate the completion of such projects, while maintaining safety, public health, and environmental protections.”

Executive Order 13605 - Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources (April 13, 2012)

Executive Order 13605 creates an Interagency Working Group to support safe and responsible development of unconventional domestic natural gas resources. The Interagency Working Group includes the Department of Interior, Department of Agriculture, Department of Defense, and other Departments. The Executive Order states: “While natural gas production is carried out by private firms, and States are the primary regulators of onshore oil and gas activities, the Federal Government has an important role to play by regulating oil and gas activities on public and Indian trust lands, encouraging greater use of natural gas in transportation, supporting research and development aimed at improving the safety of natural gas development and transportation activities, and setting sensible, cost-effective public health and environmental standards to implement Federal law and augment State safeguards.”

President’s Blueprint for a Secure Energy Future (March 30, 2011)

The Blueprint for a Secure Energy Future (White House, 2011) provides a three-part strategy, one part of which includes: *Develop and Secure America’s Energy Supplies: Expand Safe and Responsible Domestic Oil and Natural Gas Development and Production*. The Blueprint’s actions include, “Identifying the Best Public Land Sites for Development: Domestic oil and gas development, both onshore and offshore, should take place in the right places to minimize harm to the environment as well as to public health and safety. Onshore, the Administration has implemented important reforms that require adequate planning and analysis to identify potential areas where development is most appropriate. These reforms have taken place while millions of acres of public land are offered for exploration and production.”

The Blueprint’s actions also include, “Encouraging Responsible Development Practices for Natural Gas: Recent technology and operational improvements in extracting natural gas resources, particularly shale

gas, have increased gas drilling activities nationally and led to significantly higher natural gas production estimates for decades to come. In order to take full advantage of this important domestic energy resource, we must proactively address concerns that have been raised regarding potential negative impacts associated with hydraulic fracturing ("fracking") practices. That is why the Administration is taking steps to address these concerns and ensure that natural gas production proceeds in a safe and responsible manner."

FEDERAL LEASING PROCESS

The Record of Decision that accompanies this EIS decides which areas are available and which areas are unavailable for future leasing. The BLM has the authority to issue oil and gas leases in areas identified as administratively available. If a company acquires a lease, no ground disturbance can occur on the Forest unless the company applies for an Application for Permit to Drill (APD) and the APD is approved by the federal government. An environmental analysis including public involvement would be conducted by the Forest Service in cooperation with the BLM in regard to proposed roads, wells and other ground disturbance in the APD. After the environmental analysis and public involvement, the Forest Service would decide whether to approve the surface use plan of operations of the APD, and if so, with what Conditions of Approval. The BLM would decide whether to issue the APD, and if so, with what Conditions of Approval. The general steps in the oil and gas leasing and subsequent oil and gas operations process are:

(1) Forest Service and BLM leasing availability environmental analysis (Chapter 3, Section D of this FEIS)

(2) Forest Service notification to BLM of lands administratively available for leasing

(3) BLM offers lease

(4) BLM issues lease

(5) No surface disturbing activities occurs or is allowed unless and until Application for Permit to Drill APD is submitted to and authorized by BLM, including FS approval of Surface Use Plan of Operations (SUPO)

(6) If APD is submitted to BLM, then BLM and Forest Service conduct environmental analysis of proposed operations. Forest Service makes decision on approval of SUPO; BLM makes decision on approval of APD, including the Drilling Plan and SUPO.

(7) APD administered, inspected and enforced by BLM. SUPO, including interim reclamation, administered, inspected, and compliance enforced by Forest Service.

(8) BLM and Forest Service ensure final reclamation

LEASING OPTIONS

Legally Unavailable

These are lands legally unavailable, such as withdrawn from leasing by congressional designation in Wilderness or National Scenic Area legislation.

Administratively Unavailable

Forest Service determines administratively that the lands with federal rights will not be made available for leasing. Existing leases would remain in effect.

Standard Lease Terms

Standard lease terms restrict and control the lessee's use and occupancy of leased lands by subjecting the lease right to: 1) reasonable measures as may be required by the authorized officer to minimize adverse impacts to other resource values, land uses or users not addressed in the lease stipulations at the time operations are proposed, 2) restrictions deriving from specific, nondiscretionary statutes; and 3) any stipulations attached to the lease. Standard lease terms, Section 6, require, "Lessee must conduct operations in a manner that minimizes adverse impacts to land, air, and water, to cultural, biological, visual, and other resources, and to other land uses or users. Lessee must take reasonable measures deemed necessary by lessor to accomplish the intent of this section. To the extent consistent with lease rights granted, such measures may include, but are not limited to, modification to siting and design of facilities, timing of operations, and specification of interim and final reclamation measures." BLM regulation 43 CFR 3101.1-2 states: "At a minimum, measures shall be deemed consistent with lease rights granted provided that they do not: require relocation of proposed operations by more than 200 meters; require that operations be sited off the leasehold; or prohibit new surface disturbing operations for a period in excess of 60 days in any lease year."

Standard lease term operations cannot violate any other federal environmental protection laws (e.g., Clean Air Act, Clean Water Act, Endangered Species Act, etc.). Compliance with federal laws, such as the Endangered Species Act, could require use or occupancy prohibitions beyond the 200 meters or 60 day time period.

Stipulations

Stipulations are severe constraints on a lease that exceed the acreage or degree of constraints that might be expected under standard lease terms. Generally, stipulations affect contiguous areas larger than 40 acres. Some stipulations, depending on the acreage and degree of constraint, may make lease operations extremely costly and difficult, or technically or economically unfeasible.

No Surface Occupancy (NSO)

Use or occupancy of the land surface for oil and gas exploration or development is prohibited to protect identified resource values under the NSO stipulation. NSO is intended for use only when standard lease terms or other stipulations are determined insufficient to adequately protect the public interest. NSO applies to all uses and facilities associated with oil and gas development including well sites, drilling and pad construction, central tank batteries, access roads, pipelines, or other related facilities.

Timing Limitation (TL)

The TL stipulation (often called seasonal restrictions) prohibits surface use during specified time periods to protect identified resource values. A TL applies for restrictions longer than 60 days and shorter than one year. This stipulation does not apply to the operation and maintenance of production facilities unless the findings of analysis demonstrate the continued need for such mitigation and that less stringent, project-specific mitigation measures would be insufficient. Examples of a TL stipulation include, but are not limited to, limitations developed to protect wildlife during critical time periods.

Controlled Surface Use (CSU)

The CSU stipulation is intended to be used when occupancy and use are generally allowed on all or portions of the lease area year-round, but where restrictions or controls are necessary for specific types of activities rather than all activity. The CSU stipulation is used to identify constraints on surface use or operations that may otherwise exceed the mitigation provided by Section 6 of the standard lease terms and the regulations and operating orders. The stipulation should explicitly describe the activity that is to be restricted or controlled or the operation constraints required, and must identify the applicable area and the reason for the requirement.

AFFECTED ENVIRONMENT

POTENTIAL OIL AND GAS ACTIVITY ON THE GEORGE WASHINGTON NATIONAL FOREST

Oil & Gas Resources on the Forest

Oil and gas resources on the Forest are discussed in the Reasonable Foreseeable Development Scenario (RFD) prepared by BLM (Appendix K). The Marcellus Shale which occurs on more than half the Forest is the oil and gas resource of primary interest where exploration and development are reasonably foreseeable. The Utica Shale may occur at depth beneath the Forest, but its presence, continuity, geologic characteristics, and suitability as an oil and gas resource on the Forest are unknown. Exploration for the Marcellus Shale may include some exploration for the Utica Shale which, if present, would be at greater depth than the Marcellus Shale. But the development of shale gas, if it occurs on the Forest, is expected to be in Marcellus Shale. In any case, the number and type of oil and gas wells (a mix of horizontal and vertical wells), the miles of roads and pipelines, the amount of water for hydraulic fracturing, and other assumptions used for each alternative are reasonable assumptions to use to assess impacts of the alternatives.

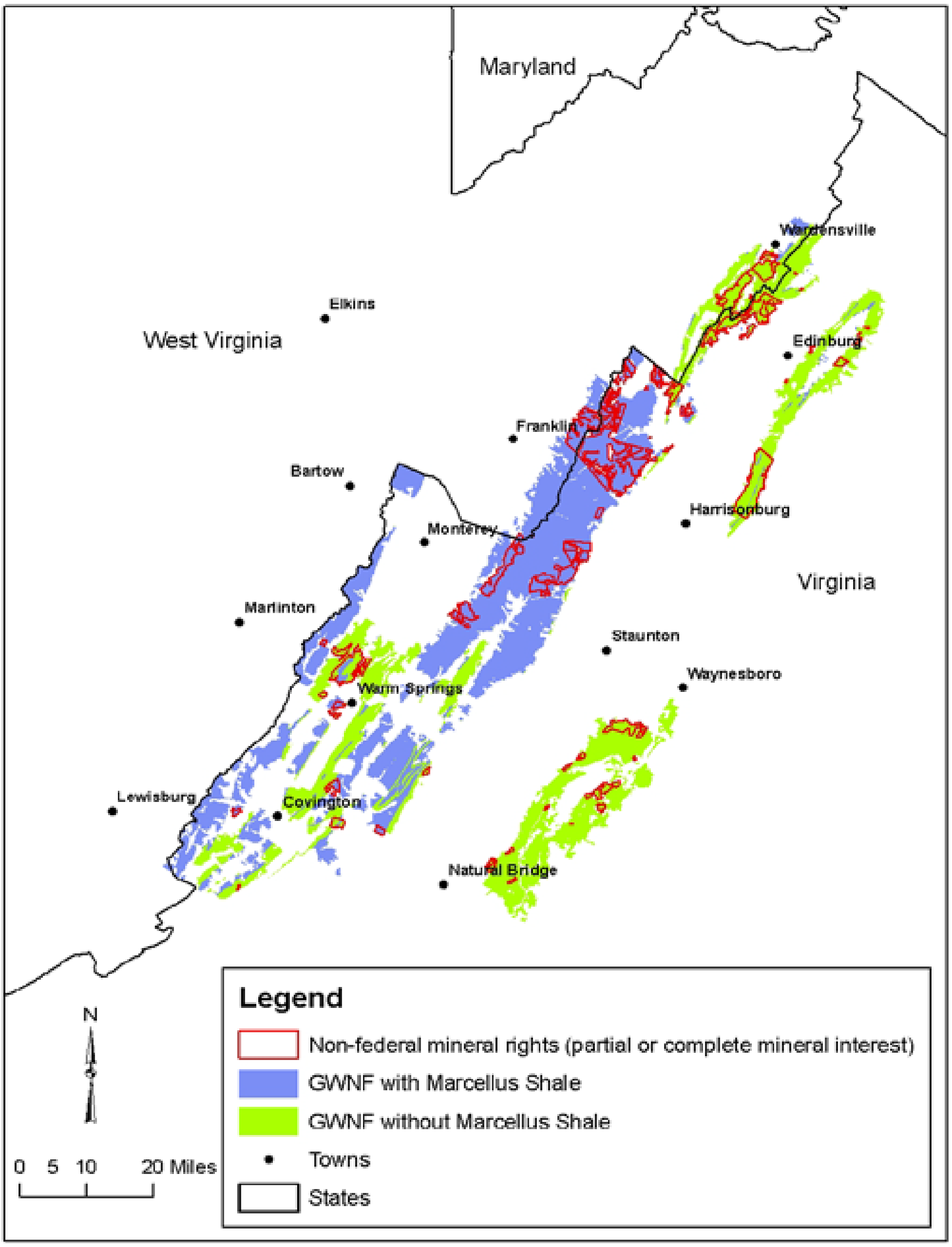

Figure 3D-1. Non-federal mineral rights on GWNF. Interpreted surface and subsurface extent of the Marcellus Shale on GWNF in Virginia and West Virginia using U.S. Geological Survey geologic map data (Dicken et al. 2005; Nicholson et al. 2005)

Marcellus Shale

The Marcellus Shale in Virginia and West Virginia is shown in Figure 3D-2 Marcellus Shale in Virginia and West Virginia, location map. The Marcellus Shale on GWNF is shown in Figure 3D-3 Marcellus Shale on GWNF in Virginia and West Virginia. The mineral status of the GWNF and relationship to Marcellus Shale is shown in GWNF Mineral Status and Marcellus Shale Table 3D-1. In a 2011 assessment of the undiscovered gas resources of the Devonian Marcellus shale, the USGS identified three Marcellus shale assessment units (Coleman et al. 2011). Lands on the GWNF lie within the Folded Marcellus Assessment Unit. It is estimated that this assessment unit contains less than 1 percent of the total undiscovered gas resources in the three assessment units.

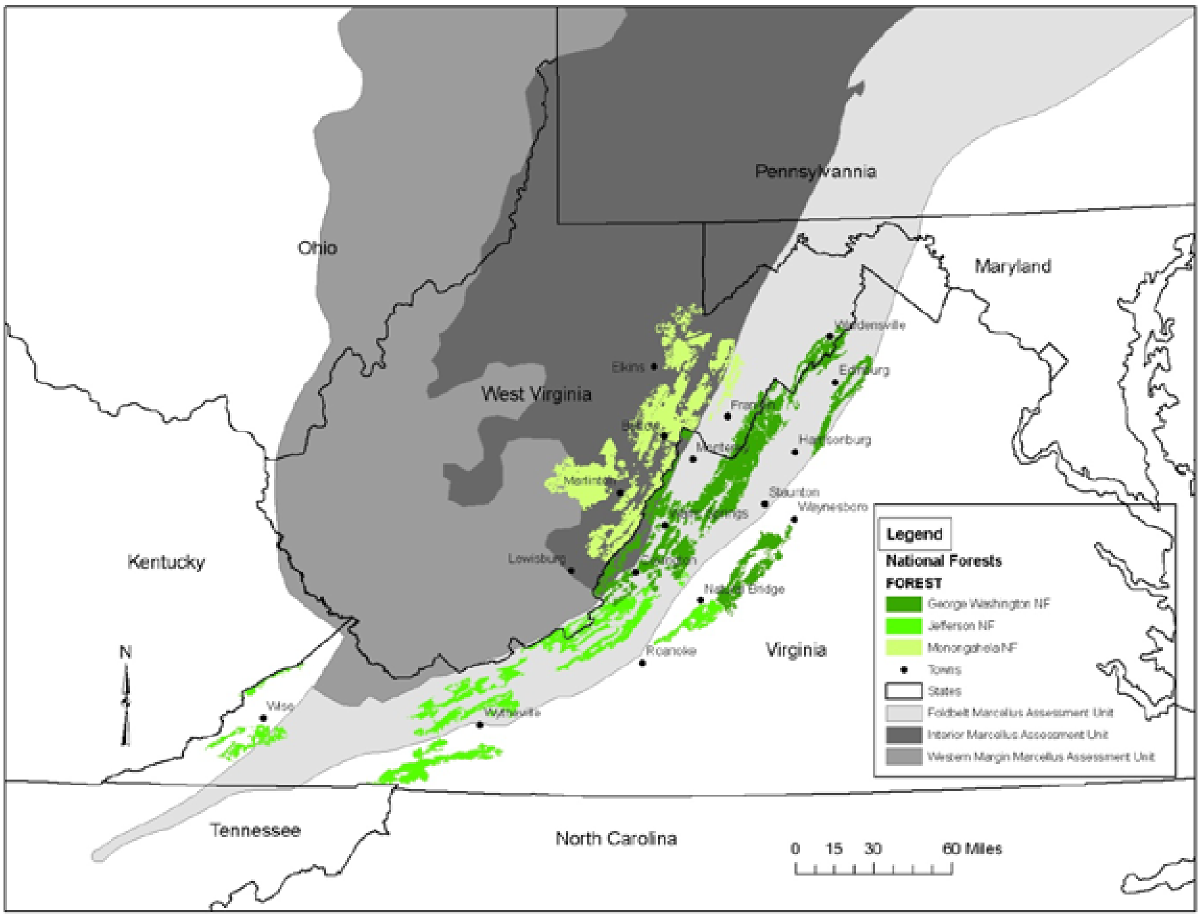

Figure 3D-2. Regional setting showing location of the George Washington NF in relation to U.S. Geological Survey Marcellus Shale Assessment Units (AU). Marcellus Shale is located within the AUs but Marcellus Shale is not present everywhere in the AU study areas, and when present may or may not be commercial for natural gas production. Most of George Washington NF is located in the Folded Marcellus AU where the Marcellus Shale is present in the subsurface on roughly half the landscape, but is not present in the subsurface on the other half of the landscape (Figure 3D-3). Modified after: U.S. Geological Survey Fact Sheet 2011–3092 (Coleman et al. 2011)

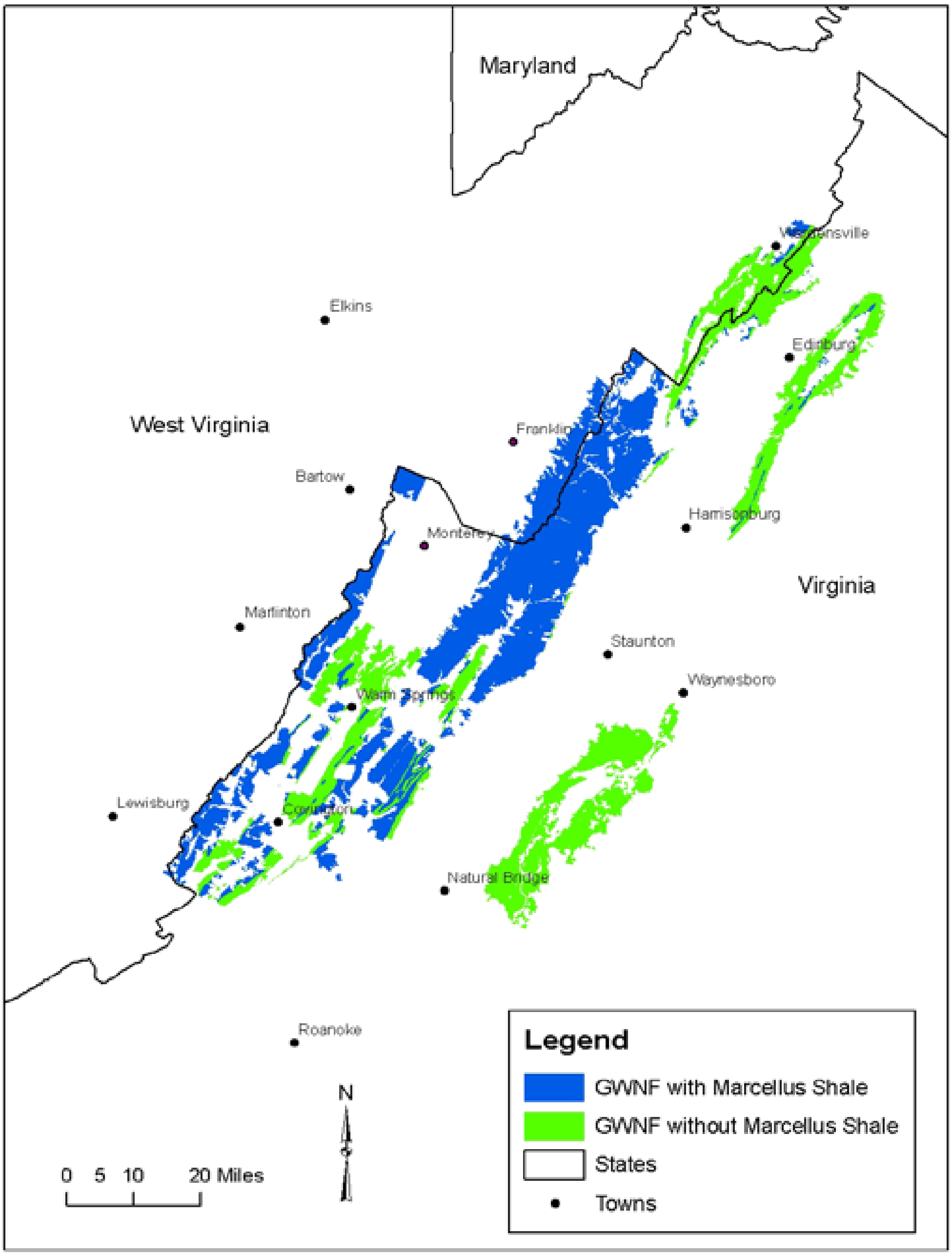

Figure 3D-3. Interpreted surface and subsurface extent of the Marcellus Shale on GWNF in Virginia and West Virginia using U.S. Geological Survey geologic map data (Dicken et al. 2005; Nicholson et al. 2005).

Table 3D-1. GWNF Mineral Status and Marcellus Shale

Mineral Status	Acres	Percent of GWNF (%)	Marcellus Shale Acres	Percent of Land Status in Marcellus Shale (%)
Total GWNF Acres	1,065,499	100.0%	592,300	55.6%
Withdrawn from mineral leasing by law	50,727	4.8%	22,537	44.4%
Not withdrawn from mineral leasing by law	1,014,772	95.2%	569,763	56.1%
Outstanding or reserved mineral rights - Partial or complete private mineral interest (subtotal of "not withdrawn" acres)	167,206	15.7%	97,615	58.4%
100% federal mineral ownership (subtotal of "not withdrawn" acres)	847,566	79.5%	472,148	55.7%
Existing federal oil & gas leases	10,243	1.0%	10,243	100.0%

Private Mineral Rights on NFS lands

The federal government owns 100% mineral rights on about 84% of the Forest. Private parties own mineral rights on about 16% of the Forest (Figure 3D-1 Non-federal mineral rights on GWNF). These outstanding or reserved mineral rights are partial or complete mineral interests. Private mineral rights are constitutionally protected property rights. Decisions on federal oil and gas leasing apply to federally-owned mineral rights, and do not apply to privately-owned mineral rights (outstanding or reserved mineral rights) on NFS lands. Oil and gas exploration and development on private mineral rights on NFS lands can occur regardless of which alternative is chosen. Assuming 16% of the GWNF Baseline Reasonably Foreseeable Development (RFD) is due to exercise of private mineral rights on the Forest, the projected oil and gas activity for private mineral rights is 16% of the GWNF Baseline RFD (Table 3D-2).

If the federal government were to acquire any private mineral rights that include oil and gas rights, then these newly-acquired federal mineral rights would be administratively available or unavailable based on the Management Prescription of the area.

Existing Federal Oil and Gas Leases

As of May 2013, federal oil and gas leases were in effect on about 1% of the Forest (10,243 acres). Oil and gas exploration and development on existing federal oil and gas leases can occur regardless of which alternative is chosen. Assuming 1% of the GWNF Baseline RFD is due to existing federal oil and gas leases, the projected oil and gas activity for existing federal oil and gas leases is 1% of the GWNF Baseline RFD (Table 3D-2). Existing federal oil and gas leases would be managed under the existing leases terms and conditions until the leases expire, terminate or are relinquished, at which time the lands would be administratively available or unavailable based on the Management Prescription of the area.

ALTERNATIVES CONSIDERED IN DETAIL

The alternatives considered for the Forest Plan decisions that are evaluated in other sections of Chapter 3 also responded to the oil and gas issue by varying the amounts and land allocations of acres that are available or unavailable for federal leasing, as well as the leasing options. Congressionally withdrawn areas, such as Wilderness and Mount Pleasant National Scenic Area (NSA), are legally unavailable for leasing for all alternatives. For the remaining areas, the suitable use associated with oil and gas leasing included whether lands would be administratively available or unavailable for federal oil and gas leasing, and if available, under what terms and conditions. The lease options are: 1) administratively unavailable; 2) available with standard lease terms and conditions; 3) available with Controlled Surface Use (CSU) or Timing Stipulation; and 4) available with No Surface Occupancy Stipulation (NSO).

Existing Conditions Common in All Alternatives

1. Congressionally withdrawn areas, such as Wilderness and Mount Pleasant National Scenic Area (NSA), are legally unavailable for federal oil and gas leasing.

2. Existing federal oil and gas leases are valid existing rights in place before the Revised Forest Plan is approved. Existing leases would be managed under the existing leases terms and conditions until the leases expire, terminate or are relinquished, at which time the lands would be administratively available or unavailable based on the Management Prescription of the area. An exception is Alterntive I where the decision is made that these lands are available for leasing.

3. The federal government owns 100% mineral rights on about 84% of the Forest. Private parties own mineral rights on about 16% of the Forest. These outstanding or reserved mineral rights are partial or complete mineral interests. Private mineral rights are constitutionally protected property rights. In each alternative, decisions on federal oil and gas leasing apply to federally-owned mineral rights, and do not apply to privately-owned mineral rights (outstanding or reserved mineral rights) on NFS lands. Oil and gas exploration and development on private minerals on NFS lands can occur regardless of which alternative is chosen. If the federal government were to acquire private mineral rights that include oil and gas rights, then these newly-acquired federal mineral rights would be administratively available or unavailable based on the Management Prescription of the area.

4. Assuming 16% of the GWNF Baseline RFD is due to private mineral rights and 1% is due to existing federal oil and gas leases, the projected oil and gas activity common for all alternatives is 17% of the GWNF Baseline RFD (Table 3D-2). The oil and gas activity comprising this 17% portion of the GWNF Baseline RFD is shown as Alternatives C and I in Table 3D-3.

Environmental Protections Common to Federal Oil and Gas Leasing in all Alternatives

Federal oil and gas leasing is subject to a wide range of federal and state laws and regulations to apply and enforce environmental protections on oil and gas exploration and development. The Department of Interior and the Department of Agriculture each has roles and regulations in administering the leasing laws Congress established for the federal oil and gas leasing program on National Forests System lands. The BLM and Forest Service each have regulations providing for environmental protections in leasing and on-the-ground operations under a lease.

1. Federal oil and gas leases have environmental protection requirements, such as in Section 6 of the standards lease terms:

> "Conduct of operations - Lessee shall conduct operations in a manner that minimizes adverse impacts to the land, air, and water, to cultural, biological, visual, and other resources, and to accomplish the intent of this section. To the extent consistent with lease rights granted, such measures may include, but are not limited to, modification to siting or design of facilities, timing of operations, and specification of interim and final reclamation measures."

2. Proposed lease operations are subject to a wide range of laws and regulations, including Endangered Species Act, Archaeological Resources Protection Act, Federal Water Pollution Control Act, Clean Water Act, Clean Air Act, National Environmental Policy Act, and all the other environmental protection laws and regulations applicable to National Forest System lands. Under a federal law such as the Endangered Species Act, the Forest Service at the Application Permit to Drill (APD) stage can control or prohibit surface occupancy of any size acreage, when justified, without a lease stipulation.

3. Two levels of environmental protections are incorporated from the National Environmental Policy Act as applied to federal oil and gas leasing. In addition to the environmental analysis under NEPA and the environmental protections developed here for determining leasing availability, a second environmental analysis under NEPA and environmental protections would be required for proposed actual operations under a lease. The Forest Service would be the lead agency and BLM a cooperating agency for NEPA for the federal decision on proposed operations on NFS lands.

After a federal oil and gas lease is issued, the leaseholder cannot construct a road, drill a well, or conduct ground disturbing operations until the federal government (BLM and Forest Service) reviews and approves plans for each proposed well, road, and associated facilities. Before ground disturbing operations can occur, the leaseholder must submit for review and approval an Application for Permit to Drill (APD) that includes a Drilling Plan and a Surface Use Plan of Operations.

4. BLM regulations for federal oil and gas lease operations have environmental protections requirements, including Onshore Oil and Gas Orders. BLM regulation Onshore Oil and Gas Order No. 1, contain environmental protection requirements for the Drilling Plan and Surface Use Plan of Operations in the APD. For example, the Drilling Plan includes ground water protection requirements such as Section IIID3:

> "The Drilling Plans must be in sufficient detail to permit a complete appraisal of the technical adequacy of, and environmental effects associated with, the proposed project. The Drilling Plan must adhere to the provisions and standards of Onshore Oil and Gas Order Number 2 (see 53 FR 46790) (Order 2) and, if applicable, Onshore Oil and Gas Order Number 6 (see 55 FR 48958) (Order 6), and must include the following information:
>
> a. Names and estimated tops of all geologic groups, formations, members, or zones.
> b. Estimated depth and thickness of formations, members, or zones potentially containing usable water, oil, gas, or prospectively valuable deposits of other minerals that the operator expects to encounter, and the operator's plans for protecting such resources.
> c. The operator's minimum specifications for blowout prevention equipment and diverter systems to be used, including size, pressure rating, configuration, and the testing procedure and frequency. Blowout prevention equipment must meet the minimum standards outlined in Order 2.
> d. The operator's proposed casing program, including size, grade, weight, type of thread and coupling, the setting depth of each string, and its condition. The operator must include the minimum design criteria, including casing loading assumptions and corresponding safety factors for burst, collapse, and tensions (body yield and joint strength). The operator must also include the lengths and setting depth of each casing when a tapered casing string is proposed. The hole size for each well bore

section of hole drilled must be included. Special casing designs such as the use of coiled tubing or expandable casing may necessitate additional information.

e. The estimated amount and type(s) of cement expected to be used in the setting of each casing string. If stage cementing will be used, provide the setting depth of the stage tool(s) and amount and type of cement, including additives, to be used for each stage. Provide the yield of each cement slurry and the expected top of cement, with excess, for each cemented string or stage.

f. Type and characteristics of the proposed circulating medium or mediums proposed for the drilling of each well bore section, the quantities and types of mud and weighting material to be maintained, and the monitoring equipment to be used on the circulating system."

The Surface Use Plan of Operations in the APD includes such requirements as:
"Section IIID4g: Methods for Handling Waste: The Surface Use Plan of Operations must contain a written description of the methods and locations proposed for safe containment and disposal of each type of waste material (e.g., cuttings, garbage, salts, chemicals, sewage, etc.) that results from drilling the proposed well. The narrative must include plans for the eventual disposal of drilling fluids and any produced oil or water recovered during testing operations. The operator must describe plans for the construction and lining, if necessary, of the reserve pit."

"Section IIID4j: Plans for Surface Reclamation: The operator must submit a plan for the surface reclamation or stabilization of all disturbed areas. This plan must address interim (during production) reclamation for the area of the well pad not needed for production, as well as final abandonment of the well location."

5. BLM regulation Onshore Oil and Gas Order No. 1 also contains General Operation Requirements with environmental protections for cultural and historic resources, Endangered Species Act, safety, and surface protection, such as Section IVc:

"Surface Protection. Except as otherwise provided in an approved Surface Use Plan of Operations, the operator must not conduct operations in areas subject to mass soil movement, riparian areas, floodplains, lakeshores, and/or wetlands. The operator also must take measures to minimize or prevent erosion and sediment production. Such measures may include, but are not limited to:

- Avoiding steep slopes and excessive land clearing when siting structures, facilities, and other improvements; and
- Temporarily suspending operations when frozen ground, thawing, or other weather-related conditions would cause otherwise avoidable or excessive impacts."

6. Onshore Oil and Gas Order No. 2 contains environmental protection requirements for Drilling Operations, such as: Section IIIB:

"The proposed casing and cementing programs shall be conducted as approved to protect and/or isolate all usable water zones, lost circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals."

7. Standard lease terms and federal regulations allow the Forest Service and BLM to 1) control surface use of proposed activities in the lease area, and 2) prohibit surface occupancy on some areas within the lease area. For example, a proposed oil and gas facility, such as a road, can be relocated up to 200 meters without any stipulation.

8. Proposed lease operations are subject to environmental protection requirements in 1) Forest Service regulations, including the 36 CFR 228E regulations developed to implement Federal Onshore Oil and Gas Leasing Reform Act of 1987, and 2) the Forest Plan. For example, the Forest Service oil and gas

regulation surface use requirements (36 CFR 228.108) require environmental protections relating to access facilities, cultural resources, fire prevention, fisheries, wildlife, plant habitat, threatened and endangered species, safety, wastes including drilling wastes, watershed protection including surface water and groundwater, erosion and sediment production, riparian areas and wetlands, and reclamation. Soil losses would be reduced or minimized through the application of Best Management Practices on a site-specific basis. Examples of such practices include use of erosion curtains to protect drainages, surfacing roads, water bars and check dams to control runoff, stockpiling of topsoil for reclamation and revegetation, and use of rip-rap to control gullying and head-cutting. Other measures include appropriate engineering design of roads, well pads, and ancillary facilities; and avoidance of steep and/or unstable slopes and sensitive soils. The Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development (commonly referred to as the Gold Book) provides operators with a combination of guidance and standards for ensuring compliance with agency policies and operating requirements, such as those found in the Code of Federal Regulations at 43 CFR 3000 and 36 CFR 228 Subpart E; Onshore Oil and Gas Orders (Onshore Orders); and Notices to Lessees (NTLs) and for use of Best Management Practices (U.S. Department of the Interior and U.S. Department of Agriculture 2007).

9. The Stipulation for National Forest System lands would be part of all leases on NFS lands and requires the lessee to comply with the Secretary of Agriculture's rules and regulations for use and occupancy of National Forest System lands prior to approval of a permit/operation plan by the Secretary of Interior.

10. Proposed lease operations are subject to the State laws and regulations governing oil and gas operations, including requirements for environmental protection and reclamation. The Virginia Department of Mines, Minerals and Energy, Division of Oil and Gas administers Virginia's Gas and Oil Act of 1990 and the regulation authorized by the act that "provides a comprehensive program to protect public safety and the environment from potential impacts associated with gas and oil exploration and development. The law and regulation govern activities from prior to the initial disturbance of land for site preparation until after a well is plugged and reclaimed. The installation and operation of gathering pipelines are also governed by the law and regulation. The Department of Mines, Minerals and Energy's (DMME) Division of Gas and Oil (DGO) is responsible for administering the law and regulation. The law and regulation require an operating permit and place special emphasis on water quality protection, erosion and sediment control, and protection of the public from safety hazards. The requirements are designed to prevent offsite disturbances from gas and oil operations." (Virginia Department of Mines, Minerals and Energy, Division of Gas and Oil 2012a).

11. Virginia Gas Well Permit Requirements include: "Permits are required for ground-disturbing geophysical exploration, exploration wells, development wells and gathering pipelines.

- Applicants for permits are required to notify parties who may be directly affected by the proposed operation, including surface owners, coal owners and mineral owners.
- These parties have the right to object to permits on specific grounds that are outlined in the law.
- Applicants also must inform local governments, and publish notices of their applications in at least one newspaper of general circulation which is published in the county, city or town where the well is proposed to be located.
- Applications must contain a description of all aspects of any operation.

"Operation plans must include a description of the following:

- The pre-development condition of the site
- The construction to be undertaken on the site including information on acreage to be disturbed, blasting activities, proposed new roads, and existing access roads
- The erosion and sediment control plan
- All well site equipment and facilities
- The design and operation of any pits

- The drilling and stimulating plan, including information on the water and constituents of the drilling fluids
- Management and disposal of pit fluids, produced waters, drill cuttings and solids

"The Virginia Division of Gas and Oil (DGO) reviews all applications and may deny a permit or require the applicant to submit more information or amend the proposed operation plan to ensure that the operator will comply with the law and regulation. Applicants must post a bond to guarantee that money is available for site reclamation and plugging should the operator fail to perform the work. The operator may not begin site work until DGO issues a permit." (Virginia Department of Mines, Minerals and Energy, Division of Gas and Oil, 2012b)

Virginia Division of Gas and Oil program for Inspection and Enforcement includes:

> "In order to insure compliance with the Virginia Gas and Oil Act and Regulation, field staff from the Division of Gas and Oil make routine inspections of well sites, gathering pipelines, facilities and other permitted sites and activities. Frequency of inspection is determined by a priority system which categorizes each permitted site or operation according to its level of activity or the stability of the associated disturbed area. Highest priority for inspection is given to sites that are under construction or being drilled or completed, while lowest priority is given to older permits with stabilized sites.
>
> "If inspections reveal a lack of regulatory compliance, actions that may be taken range from obtaining voluntary compliance through requests or warnings to revocation of permits. If voluntary compliance cannot be achieved, the problem involves off-site disturbance, or, at the discretion of the inspector, the infraction is sufficiently severe, a Notice of Violation may be issued to the permittee. The Notice of Violation may be accompanied by recommendations for Civil Charges.
>
> "If conditions causing the issuance of a Notice of Violation are not abated, or if a condition or practice on a permitted site creates an imminent danger to the health and safety of the public, a Closure Order may be issued which causes cessation of operations until the conditions are corrected. If compliance cannot be achieved by any of the means described above, permits can be suspended or revoked and bonds may be forfeited for the purpose of plugging wells or reclaiming sites." Virginia Department of Mines, Minerals and Energy, Division of Gas and Oil. 2012c

On October 17, 2011 the Commonwealth of Virginia provided more information about Virginia Department of Mines, Minerals and Energy (DMME) gas and oil regulations:

> "DMME gas and oil regulations would apply to any wells drilled within GWNF. These regulations require submission and approval of a stimulation plan. This plan must address the specifics of how the well will be stimulated, including fluids to be used, additives, and other factors. DMME gas and oil permitting requires the operator to complete site-specific assessments of the surface and underground conditions to be affected by drilling, to ensure that operation will not cause off-site disturbances or pollution to surface or groundwater."
>
> "To date, there have been no known instances of surface water or groundwater degradation from hydraulic fracturing in Virginia. This is largely due to casing and fluid management requirements that must be met when drilling and stimulating a well. There are multiple layers of steel pipe and concrete extending through groundwater zones that provide protection and prevent the intrusion of water into a gas flow stream. Cement casing is required at least 300 feet below the surface or 50 feet beneath the deepest known groundwater horizon, whichever is deeper. Typically, hydraulic fracturing is conducted in formations that are at least 500 feet, and often thousands of

feet (for shale) below fresh water zones. These requirements ensure protection of groundwater from well stimulation fluids."

"DMME regulations also protect water quality once the fluids return to the surface…No off-site disturbances or discharges are allowed. Fluids are normally disposed of in an off-site permitted facility such as a Class II EPA injection well. Well operators are also increasingly reusing or recycling stimulation fluids in order to minimize disposal. DMME gas and oil regulations also govern on-site road and gathering pipeline construction and operation. Construction must meet all erosion and sediment control, storm water, and reclamation requirements, and are covered under performance bonds." (Virginia Department of Environmental Quality 2011)

12. The State of West Virginia also has law, regulation, and permit requirements for oil and gas operations. West Virginia Code of State Rules Title 35 includes Oil and Gas Wells and Other Wells requirements (West Virginia Secretary of State 2012a) such as:

- Prevention of surface and underground water pollution
- Operational Regulations on Liquid Injection and Waste Disposal Wells
- Fresh Water Casing
- Water Supply Testing and Notice to Surface Owners
- Construction and maintenance of drilling sites to prevent spills and excess sedimentation.
- Construction and maintenance of wastewater pits and freshwater impoundments
- Requirements for Pipelines
- Inspection and Enforcement
- Groundwater Remediation
- Bonds
- Plugging, Abandonment and Reclamation

In August 2011 West Virginia issued Rules Governing Horizontal Well Development (West Virginia Secretary of State 2012b) that includes requirements such as:

- Operational rules to protect quality and quantity of water in surface and ground water systems.
- Casing and cement standards to keep fluids or natural gas from entering ground or surface waters.
- Water Management Plan
- A listing of anticipated additives that may be used in the water used for fracturing or stimulating the well, and upon completion, a listing of the additives that were actually used.
- Identification of the current designated and existing water uses, including any public water intakes within one mile downstream of the withdrawal location.
- A demonstration, using methods acceptable to the Secretary, that sufficient in-stream flow will be available downstream of the point of withdrawal.
- Identification of the methods to be used to prevent significant adverse impact to aquatic life.
- Well Site Safety Plan
- Material Safety Data Sheets (MSDS) for all materials and chemicals on the well site shall be readily available and maintained at the well site.

In December 2011 West Virginia passed the Horizontal Well Development Act (Natural Gas Horizontal Well Control Act) (West Virginia Legislature 2011) that includes requirements such as:

- Protection of quality and quantity of water in surface and ground water systems both during and after drilling operations and during reclamation.
- Well location distance restrictions in relation to water wells, residences, perennial streams, naturally producing trout streams, and public surface or groundwater intakes.
- Water Management Plan
- A listing of anticipated additives that may be used in the water used for fracturing or stimulating the well, and upon completion, a listing of the additives that were actually used.

- Identification of the current designated and existing water uses, including any public water intakes within one mile downstream of the withdrawal location.
- A demonstration, using methods acceptable to the Secretary, that sufficient in-stream flow will be available immediately downstream of the point of withdrawal.
- Methods to be used for surface water withdrawals to minimize adverse impact to aquatic life.
- The planned management and disposition of wastewater after completion from fracturing, refracturing, stimulation and production activities;
- Casing and cement standards. Casing, sealing or otherwise managing wells to keep returned fluids from entering ground and surface waters.
- Erosion and sediment control plan
- Protection for karst terrain including caves and sinkholes.

Reasonable Foreseeable Development Scenario (RFD)

Projections of the kind and amount of oil and gas activity that could be reasonably anticipated were made in order to analyze the environmental effects that could occur as a result of federal oil and gas leasing under each alternative. Forest Service regulations (36 CFR 228.102 (c) (3 and 4)) require the analysis to “project the type/amount of post-leasing activity that is reasonably foreseeable as a consequence of conducting a leasing program consistent with that described for each alternative” and “analyze the reasonable foreseeable impacts of post-leasing activity under (c)(3) of this section as a part of the analysis.” This post-leasing activity is the oil and gas activity, including construction of roads, well pads, pipelines, and associated facilities that would be expected under each alternative.

Projecting the post-leasing activity is a multi-step process that begins with a Reasonable Foreseeable Development Scenario (RFD) prepared by the Bureau of Land Management (BLM) (Appendix K). The RFD provides a baseline projection of post-leasing activity from which projections for each alternative are developed. To provide the baseline projection the BLM prepared a Reasonable Foreseeable Development Scenario based on the assumption that all the Forest except areas withdrawn from leasing by law (Wilderness and National Scenic Area) would be available for oil and gas leasing under standard lease terms and conditions (Appendix K-BLM RFD). The BLM baseline RFD estimates post-lease activity of 319 natural gas wells and associated surface disturbance including wells pads, roads, and pipelines over a 15 year planning horizon.

The BLM baseline RFD assumptions for surface disturbance are modified here by adding acres associated with pipelines and water use for drilling. The resulting RFD assumptions for surface disturbance, water use, and reclamation are:

Drilling Phase:

- Seismic Exploration (Vibroseis): 163 miles on existing roads and the use of heliportable seismic equipment in other areas (casual use minimal disturbance)
- Exploration/Evaluation Well Pad (vertical well) - (300’x300’ pad): 2.07 acres per pad
- Exploratory/Evaluation Well Pad (vertical well) Access Road (40’x 1.5 mile/well): 7.27 acres per road
- Development Well Pad (vertical well) - (300’x300’): 2.07 acres per pad
- Development Well Pad (vertical well) Access Roads (40’x1.0 mile/well): 4.85 acres per road
- Development Well Pad (horizontal wells, 3 wells per pad) (500’x500’ pad): 5.74 acres per pad
- Development Well Pad (horizontal wells, 3 wells per pad) Access Road (40’x2.0 miles/pad): 9.70 acres per pad
- Water use for drilling vertical well: 20,000 gallons per well.
- Water use for drilling horizontal well: 100,000 gallons per well.

Post-drilling and Production Phase:

- Initial Reclamation: Part of Exploration/Evaluation Well Pad (vertical well) reclaimed: 1.84 acres per pad
- Part of Exploration/Evaluation Well Pad (vertical well) used for production: 0.23 acres per pad
- Initial Reclamation: Part of Development Well Pad (vertical well) reclaimed: 1.84 acres per pad
- Part of Development Well Pad (vertical well) used for production: 0.23 acres per pad
- Water use for hydraulic fracturing of vertical well: 400,000 gallons per well.
- Water use for hydraulic fracturing of horizontal well: 5,000,000 gallons per well.
- Initial Reclamation: Part of Development Well Pad (horizontal wells, 3 wells per pad) reclaimed: 5.22 acres per pad
- Part of Development Well Pad (horizontal wells, 3 wells per pad) used for production: 0.52 acres per pad
- Pipelines along road (additional 20’ width along 90% of road miles): 2.18 acres per mile of road. Pipelines not along roads (10% of road miles) and pipelines connecting to the area or field (additional mileage estimated at 10% of road miles) - (30’ wide corridor estimated as 20% of road miles): 0.73 acres per mile of road. Pipelines along roads and pipelines outside roads corridor: total 2.91 acres per mile of road.
- Off well site production facilities: 25 acres
- Final Reclamation: road acres + well pad acres + pipeline acres+ off well site production facilities acres.

Using these assumptions, the modified RFD is shown in the 3D-2 GWNF Baseline RFD Table.

Table 3D-2. GWNF Baseline Reasonably Foreseeable Development (RFD)

Activity	GWNF federal and private mineral ownerships Baseline RFD			
	Exploration/evaluation wells (vertical)	Development wells (vertical)	Development wells (horizontal)	Total
Number of wells	20	50	249	319
Roads (miles)	30	50	166	246
Roads (acres)	145	242	805	1193
Well Pads (acres)	41	103	476	621
Road & Well Pads (acres)	187	346	1,281	1,814
Well pads initial reclamation (acres)	37	92	433	562
Well pads in production (acres)	5	12	43	59
Pipelines (miles)	33	55	183	271
Pipelines (acres)	96	160	531	787
Off Site Production Facilities (acres)	0	0	25	25
Production reclamation (acres)	237	399	1,331	1,993
Total reclamation (total disturbance) (acres)	274	491	1,764	2,555
Water use for drilling (1,000s of gallons)	400	1,000	24,900	26,300
Water use for hydraulic fracturing (1,000s of gallons)	8,000	20,000	1,245,000	1,273,000

This projection of future oil and gas activity is based on the assumption that all the Forest except areas withdrawn from leasing by law would be available for oil and gas leasing under standard lease terms and conditions. Because each alternative will have more restrictive constraints on availability of federal oil and gas leasing, each alternative will project less oil and gas activity than the GWNF baseline RFD. Before projecting the future federal oil and gas activity that varies by alternative, the following section will consider the part of the future activity (GWNF baseline RFD Table) that is common to all alternatives and does not vary by alternative.

Additional Stipulations Used in Alternatives B, D, and F

In addition to leasing availability and leasing options, two additional stipulations were developed for the alternatives in the Draft Environmental Impact Statement for several alternatives. These stipulations included the following:

Horizontal Drilling Moratorium: The surface management agency (USDA-Forest Service) would have a moratorium on processing Surface Use Plan of Operations of an Application for Permit to Drill for any horizontal well and associated hydraulic fracturing. The moratorium would end on May 1, 2015. This would allow for the consideration of additional information, such as information developed by U.S. Environmental Protection Agency, for use in processing Application for Permit to Drill for horizontal wells with multi-stage hydraulic fracturing.

Horizontal Drilling Operations Control Stipulation: In cooperation with BLM, the USDA-Forest Service would scrutinize proposed operations in regard to use and disposal of surface water and groundwater, and the type and amounts of materials used in hydraulic fracturing. Applicants for Surface Use Plan of Operations of APD shall supply a list of the quantity and chemical composition of all materials proposed for use in drilling and hydraulic fracturing, including any associated Material Safety Data Sheets. The Drilling Plans must be in sufficient detail to permit a complete appraisal of the technical adequacy of the ground water protection components of the proposed drilling. The proposed casing and cementing programs shall be designed to protect and/or isolate all usable water zones, lost circulation zones, and abnormally pressured zones. The operator shall submit the proposed casing program, including size, grade, weight, type of thread and coupling, the setting depth of each string, and its condition. The operator must include the minimum design criteria, including casing loading assumptions and corresponding safety factors for burst, collapse, and tensions (body yield and joint strength). Based on an the environmental analysis, the USDA-Forest Service will determine whether use of surface water and/or groundwater on National Forest System (NFS) lands will be authorized. Use of surface water and/or groundwater may be severely limited or prohibited. Prior to conducting hydraulic fracturing operation, the operator shall submit as-built wellbore construction information so that the APD administrators (BLM and Forest Service) can assess: adequacy of surface casing to protect fresh water and to isolate potable fresh water supplies from deeper gas-bearing zones; adequacy of cement in the annular space around the surface casing; adequacy of cement on production (and intermediate) casing to prevent upward migration of fluids during all reservoir conditions; and use of centralizers to ensure that the cement sheath surrounds the casing strings. No hydraulic fracturing operation shall commence until the APD administrators provide authorization for the operation after a review of the as-built wellbore construction information. After authorization is granted, the operator shall provide the APD administrators with at least three days' notice before commencing hydraulic fracturing operation. Flowback operations shall use above ground storage tanks rather than surface impoundments. The fluid disposal plan must demonstrate that flowback water pipelines and conveyances will be constructed of suitable materials, maintained in a leak-free condition, regularly inspected and operated using all appropriate spill control and storm water pollution prevention practices. Surface disposal of hydraulic fracturing materials on NFS lands will not be authorized. Based on an environmental analysis, the USDA-Forest Service will determine whether subsurface disposal of hydraulic fracturing materials in an EPA-approved underground injection well on NFS lands will be authorized or prohibited.

Alternative A – No Action Alternative

Alternative A represents the leasing availability decision that was made concurrently with the 1993 Forest Plan, as amended through ten amendments. Of the 1,055,000 acres available for leasing, approximately 954,000 acres would be available under standard lease terms and controlled surface use occupancy stipulations. The Plan did not address horizontal drilling and high volume hydraulic fracturing since its use was not common at that time. There is no direction in the 1993 Plan or any of the amendments for the development of the Marcellus shale formation. The 10,000 acres that are administratively unavailable include the Laurel Fork area.

Alternative B

This alternative is based on changes to the 1993 Forest Plan identified in the Analysis of the Management Situation. The analysis was based on an IDT evaluation of the 1993 Forest Plan direction, monitoring and evaluation results, new policies, best available science and an attempt to balance public issues that were identified as of March 2010 for the Notice of Intent. In Alternative B, of the 983,000 acres available for leasing, approximately 767,000 acres are available under standard lease terms or controlled surface occupancy stipulations. Horizontal drilling (Marcellus shale development) is allowed on all available acres but the Horizontal Drilling Moratorium and the Horizontal Drilling Operations Control stipulations are applied. The 22,100 acres that are administratively unavailable include the Recommended Wilderness Study areas.

Alternative C

In this alternative, the emphasis is restoration and maintenance of sustainable ecological systems predominantly through natural processes, with little human intervention beyond what it required to meet legal requirements. It also addresses the need for non-motorized recreation opportunities. No new areas would be available for federal oil and gas leasing. Existing leases would remain in effect. Private mineral rights (approximately 167,200 acres) would continue to be legally available for oil and gas leasing.

Alternative D

In this alternative, restoration and maintenance of natural ecological systems would use practices that also produce a higher level of commodities and offers amenities that enhance tourism for local communities that benefit economically from forest visitors and forest products. Of the 981,000 acres available for leasing, approximately 766,000 acres are available under standard lease terms or controlled surface occupancy stipulations. Horizontal drilling (Marcellus shale development) allowed on all available acres but the Horizontal Drilling Moratorium and the Horizontal Drilling Operations Control stipulations are applied. The 24,500 acres that are administratively unavailable include Recommended Wilderness Study areas and a Recommended National Scenic Area.

Alternative E

Alternative E would actively restore and maintain vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Of the 980,000 acres available for leasing, approximately 695,000 acres are available under standard lease terms or controlled surface occupancy stipulations. No acres would be available for horizontal drilling (Marcellus Shale development).

Alternative F

This alternative would restore and maintain the native ecological systems while also creating many opportunities for a variety of recreation settings. The emphasis is on recreation opportunities, scenery management, and wilderness designation, while focusing ecosystem health activities in support of wildlife based recreation. Of the 763,000 acres available for leasing, approximately 600,000 acres are available under standard lease terms or controlled surface occupancy stipulations. Horizontal drilling (Marcellus shale development) would not be allowed on approximately 31,500 acres of public water supply watersheds. The remaining 731,500 available acres would be subject to the Horizontal Drilling Moratorium and the Horizontal Drilling Operations Control stipulations. The 241,800 acres that are administratively unavailable include Recommended Wilderness Study areas and Recommended National Scenic Areas.

Alternative G

Alternative G was developed after reviewing public comments and agency concerns received and developed before the Draft EIS was released. It was identified as the Preferred Alternative in the Draft EIS. This alternative provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. It would actively restore and maintain vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest. Of the 983,000 acres available for leasing, approximately 711,000 acres are available for leasing under standard lease terms or controlled surface occupancy stipulations. No areas would be available for horizontal drilling (Marcellus Shale development). The 22,000 acres of administratively unavailable acres include Recommended Wilderness Study Areas.

Alternative H

Alternative H was developed after reviewing public comments and new information received after release of the Draft EIS. It is based on Alternative G with changes made in response to the comments and further analysis. This alternative provides a variety of resource benefits, including wood, wildlife, fish, range, dispersed recreation, developed recreation, minerals, wilderness and special uses, in a manner that maintains the diversity, productivity and long-term sustainability of ecosystems. It would actively restore and maintain vegetative compositional and structural conditions needed to provide for a variety of terrestrial and aquatic species in certain areas of the forest.

A major change from Alternative G is the decision to base the leasing availability analysis on only those acres with a high potential for gas development, which includes the James River Ranger District and most of the North River and Warm Springs Ranger Districts. Alternative H makes no decision on the availability of lands on the Lee and Pedlar Ranger Districts, on Walker Mountain on the North River Ranger District, and on Back Creek Mountain and Warm Springs Mountain on the Warm Springs Ranger District. This is based on the Reasonably Foreseeable Development Scenario (Appendix K) which identifies the Marcellus shale as the formation with a high potential for gas. If there is a future interest in leasing these deferred areas of the GWNF, a site-specific analysis would be done to determine the availability of those specific areas.

Another major change from Alternative G is the decision to allow hydraulic fracturing with additional stipulations on certain areas of the GWNF. Of the 461,000 acres available for leasing, approximately 236,000 are available under standard lease terms, 88,000 acres under controlled surface use stipulations and 137,000 under no surface occupancy stipulations. Most leasing options apply to an entire management area prescription, but there are several exceptions. The area within Management Prescription Area 13-Mosaics of Habitat on Shenandoah Mountain south of Highway 250 and above 3,000 feet in elevation are available but with no surface occupancy stipulations to protect potential habitat for the Cow Knob salamander. Portions within Semi-Primitive Non-Motorized and Semi-Primitive Motorized settings are available with controlled surface use stipulations that will limit road construction. The 128,000 acres that are administratively unavailable for leasing include: Recommended Wilderness Study areas, Shenandoah Mountain Recommended National Scenic Area, Laurel Fork, Indiana Bat-Primary Area Conservation Areas, and public water supply watersheds.

Alternative H includes a different set of mitigation and control measures for reducing potential impacts from gas drilling. These measures are described in Appendix I.

Alternative I

Alternative I was developed after reviewing public comments and new information received after release of the Draft EIS. Alternative I is the same as Alternative H except for the oil and gas leasing availability component. With respect to the availability of lands for federal oil and gas leasing, Alternative I uses the approach for administrative availability of Alternative C where no new areas would

be available for federal oil and gas leasing, except Alternative I makes the lands with existing leases available after the current leases expire. Existing leases (approximately 10,200 acres) would remain in effect. Private mineral rights (approximately 167,200 acres) would not be affected.

The following two tables compare the differences between the alternatives with respect to the amount of available acres for leasing, the leasing options and the suitability of leasing for specific management prescriptions areas or other resource conditions on the GWNF.

Table 3D-3. Federal Oil and Gas Leasing Availability by Alternative (thousands of acres)

Category	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Administratively Available	995	983	0	981	980	763	983	461
Standard Lease Terms	139	615	0	609	535	495	550	236
Controlled Surface Use Stipulation	815	152	0	157	160	105	161	88
Timing Stipulation	0	14	0	14	14	14	14	0
No Surface Occupancy Stipulation	41	202	0	201	271	149	259	137
Administratively Unavailable	10	22	1,005	25	26	242	22	128
Legally Unavailable	51	51	51	51	51	51	51	51
Administratively Available Decision Deferred*	0	0	0	0	0	0	0	416
Available, Under Existing Lease	10	10	10	10	10	10	10	10
Total Forest Acres	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066
Additional Control Measures on Drilling Operations	0	983	0	981	0	731	0	461
Horizontal Drilling Moratorium	0	983	0	981	0	731	0	0
No Horizontal Drilling Stipulation	0	0	0	0	980	32	983	0

*Administratively available decision deferred on Pedlar and Lee Ranger Districts and portions of the Warm Springs and North River Ranger Districts.

Table 3D-4. Oil and Gas Leasing Options by Management Prescription Area

Rx	Management Prescription Area Description	Oil and Gas Leasing Availability Alts A, B, D, E, F and G	Oil and Gas Leasing Suitability Alt H*
1A	Designated Wilderness	Legally Unavailable	Legally Unavailable
1B	Recommended Wilderness Study	Administratively Unavailable	Administratively Unavailable
2C2	Eligible Wild and Scenic River-Scenic	CSU	NSO
2C3	Eligible Wild and Scenic River-Recreation	CSU	NSO
4A	Appalachian Trail Corridor	NSO	NSO
4B1	Research Natural Areas	NSO	NSO
4C1	Geologic Areas	CSU	NSO
4D	Special Biological Areas	CSU	NSO
4D1	Key Natural Heritage Community Area	CSU	NSO
4E	Cultural/Heritage Areas	NSO	NSO
4F	Mt Pleasant National Scenic Area	Legally Unavailable	Legally Unavailable
4FA	Recommended National Scenic Areas	Administratively Unavailable	Administratively Unavailable

Rx	Management Prescription Area Description	Oil and Gas Leasing Availability Alts A, B, D, E, F and G	Oil and Gas Leasing Suitability Alt H*
5A	Administrative Sites	Standard	Standard
5B	Communication Sites	Standard	Standard
5C	Utility Corridors	Standard	Standard
7A1	Scenic Byways	CSU	CSU
7B	Scenic Corridors and Viewsheds	CSU	CSU
7C	ATV Use Areas	Standard	Standard
7D	Concentrated Recreation Areas	CSU	CSU
7E	Dispersed Recreation Areas	Standard	Standard
7E1	Dispersed Recreation Areas-Unsuitable for Timber Production	Standard	Standard
7E2	Dispersed Recreation Areas-Suitable	Standard	Standard
7F	Blue Ridge Parkway Corridor	CSU	CSU
7G	Pastoral Landscapes	Standard	Standard
8A1	Mix of Successional Habitats	Standard	N/A
8A1U	Mix of Successional Habitats-Unsuitable for Timber Production	Standard	N/A
8B	Early Successional Habitats	Standard	N/A
8BU	Early Successional Habitats-Unsuitable	Standard	N/A
8C	Black Bear/Remote Habitats	Standard	N/A
8CU	Black Bear/Remote Habitats-Unsuitable	Standard	N/A
8E4a	Indiana Bat-Primary Conservation	Administratively Unavailable	Administratively Unavailable
8E4b	Indiana Bat-Secondary Conservation	Timing	NSO
8E7	Shen Mtn Crest-Cow Knob Salamander	CSU	NSO
9A1	Source Water Watershed Protection	CSU	N/A
10B	Timber Production	Standard	N/A
10BU	Timber Production-Unsuitable	Standard	N/A
11	Riparian Areas and Corridors	CSU	CSU
12D	Remote Backcountry Areas	NSO	NSO
13	Mosaics of Habitat-Suitable	Standard	Standard
13U	Mosaics of Habitat-Unsuitable	Standard	N/A
	Laurel Fork Area	Administratively Unavailable	Administratively Unavailable

*Public Supply Watersheds (including the watershed upstream of the Dry River PWS) are administratively unavailable and can contain multiple management prescription areas. Portions of Rx 13 that are on Shenandoah Mountain south of Highway 250 and above 3,000 feet in elevation are NSO. Portions within Semi-Primitive Non-Motorized and Semi-Primitive Motorized settings are CSU.

Oil & Gas Activity by Alternative

The potential federal oil and gas activity on 100% federal mineral ownership for each alternative is shown in Table 3D-5 GWNF Federal Oil & Gas Lease Activity by alternative on 100% federal mineral ownership.

Table 3D-5. GWNF New Federal Oil & Gas Lease Activity by Alternative on 100% Federal Mineral Ownership

Activity	Federal 100% Mineral Ownership Baseline RFD				Alt A				Alt B			
	Exploration/ Evaluation wells (vertical)	Develop-ment wells (vertical)	Development wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	17	42	207	265	16	39	198	253	12	30	153	195
Roads (miles)	25	42	138	204	24	39	132	195	12	30	51	94
Roads (acres)	121	201	668	990	114	191	639	944	59	148	247	380
Well Pads (acres)	34	86	476	596	33	81	378	492	25	63	292	380
Road & Well Pads (acres)	155	287	1,144	1,586	147	272	1,017	1,436	84	210	539	833
Well pads initial reclamation (acres)	31	76	433	540	29	72	344	445	22	56	266	344
Well pads in production (acres)	4	10	36	49	4	9	34	47	3	7	26	36
Pipelines (miles)	27	46	152	225	26	43	145	214	13	33	56	103
Pipelines (acres)	72	121	401	594	69	114	383	566	35	89	148	272
Off Site Production Facilities (acres)	0	0	0	21	0	0	0	24	0	0	0	19
Production reclamation (acres)	197	331	1,105	1,654	187	314	1,057	1,581	97	243	421	781
Total reclamation (total disturbance) (acres)	228	408	1,538	2,194	216	386	1,401	2,027	120	299	687	1,125
Water use for drilling (1,000s of gallons)	332	830	20,667	21,829	315	787	19,767	20,868	244	609	15,267	16,119
Water use for hydraulic fracturing (1,000s of gallons)	6,640	16,600	1,033,350	1,056,590	6,292	15,731	988,350	1,010,373	4,871	12,177	763,350	780,397

Activity	Alts C and I				Alt D				Alt E			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	0	0	0	0	12	30	153	195	11	27	0	37
Roads (miles)	0	0	0	0	12	30	51	93	5	13	0	19
Roads (acres)	0	0	0	0	59	147	247	453	26	65	0	91
Well Pads (acres)	0	0	0	0	25	63	292	380	22	55	0	77
Road & Well Pads (acres)	0	0	0	0	84	210	539	833	48	120	0	168
Well pads initial reclamation (acres)	0	0	0	0	22	56	266	344	20	49	0	69
Well pads in production (acres)	0	0	0	0	3	7	26	36	2	6	0	9
Pipelines (miles)	0	0	0	0	13	33	56	103	6	15	0	21
Pipelines (acres)	0	0	0	0	35	88	148	272	16	39	0	54
Off Site Production Facilities (acres)	0	0	0	0	0	0	0	19	0	0	0	18
Production reclamation (acres)	0	0	0	0	97	243	421	761	44	110	0	154
Total reclamation (total disturbance) (acres)	0	0	0	0	119	299	687	1,105	64	159	0	222
Water use for drilling (1,000s of gallons)	0	0	0	0	243	608	15,267	16,118	214	534	0	747
Water use for hydraulic fracturing (1,000s of gallons)	0	0	0	0	4,863	12,158	763,350	780,372	4,271	10,676	0	14,947

Activity	Alt F				Alt G				Alt H			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	9	22	114	144	11	27	0	38	8	19	96	122
Roads (miles)	4	11	19	34	5	14	0	19	4	10	16	29
Roads (acres)	21	53	92	166	27	67	0	93	18	46	77	142
Well Pads (acres)	18	45	217	281	23	57	0	79	16	39	183	238
Road & Well Pads (acres)	39	98	309	446	49	123	0	173	34	85	260	380
Well pads initial reclamation (acres)	16	40	198	254	20	51	0	71	14	35	166	215
Well pads in production (acres)	2	5	20	27	3	6	0	9	2	4	17	23
Pipelines (miles)	5	12	21	38	6	15	0	21	4	10	18	32
Pipelines (acres)	13	32	55	100	16	40	0	56	11	28	46	85
Off Site Production Facilities (acres)	0	0	0	15	0	0	0	18	0	0	0	21
Production reclamation (acres)	36	90	167	292	45	113	0	158	31	78	140	250
Total reclamation (total disturbance) (acres)	52	130	364	546	65	163	0	229	45	113	307	465
Water use for drilling (1,000s of gallons)	174	436	11,367	11,978	220	550	0	769	152	381	9,567	10,100
Water use for hydraulic fracturing (1,000s of gallons)	3,489	8,722	568,350	580,561	4,397	10,992	0	15,389	3,045	7,611	478,350	489,006

Alternatives B through H identify some areas available only under No Surface Occupancy and many of the areas are relatively remote. This means that the remaining areas available for Standard or Controlled Surface Use would likely have better existing access and require fewer roads to access the well pads. Therefore, in Alternatives B and D the estimate for miles of road per well pad is changed to one mile. In Alternatives E, F, G, and H the estimate is changed to one-half mile of road per well pad.

Cumulative Oil & Gas Activity on GWNF by Alternative

The cumulative future oil and gas activity from both projected federal and private oil & gas lease activity on GWNF for each alternative is shown in Table 3D-6 GWNF cumulative oil & gas activity (projected federal and private oil & gas lease activity on GWNF).

Past oil and gas activity on the Forest consists of five oil and gas wells drilled on federal oil & gas leases during the 1970 to 2000 period; the five wells were dry holes. Currently the Forest does not have any active federal oil and gas wells. No private oil and gas wells (outstanding or reserved mineral rights) were drilled on the Forest in the past, and no private oil and gas wells are present on the Forest. The cumulative impacts from oil and gas activity would be mostly due to cumulative future oil and gas activity projected under each alternative (Table 3D-6). The cumulative future oil and gas activity has two parts. The first part is the future federal oil & gas lease activity on 100% federal mineral ownership (Table 3D-5). The second part is the future oil & gas lease activity on 1) existing federal leases and 2) private mineral rights (outstanding or reserved mineral rights). Oil and gas activity for this second part is shown under Alternatives C and I in Table 3D-6. Because no lands would be administrative available for new federal oil and gas leasing under Alternatives C and I, the only oil and gas activity under Alternatives C and I would be on existing rights (private mineral rights (outstanding or reserved mineral rights) or existing federal leases. Adding this second part activity to the each alternative's activity in the first part (Table 3D-5) yields the cumulative future oil and gas activity (Table 3D-6).

Table 3D-6. GWNF cumulative future oil & gas activity (projected federal and private oil & gas lease activity on GWNF) Table

Activity	GWNF (federal and private mineral ownerships) Baseline RFD				Alt A				Alt B			
	Exploration/ Evaluation wells (vertical)	Development wells (vertical)	Development wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	20	50	249	319	19	48	240	307	16	39	195	250
Roads (miles)	30	50	166	246	29	48	160	237	16	39	65	120
Roads (acres)	145	242	804	1,193	139	232	776	1,147	76	189	315	579
Well Pads (acres)	41	103	476	621	40	99	459	597	32	80	373	486
Road & Well Pads (acres)	187	346	1,281	1,814	179	331	1,235	1,744	108	269	688	1,065
Well pads initial reclamation (acres)	37	92	433	562	35	88	418	541	29	72	339	440
Well pads in production (acres)	5	12	43	59	4	11	42	57	4	9	34	46
Pipelines (miles)	33	55	183	271	32	53	176	260	17	43	72	131
Pipelines (acres)	87	145	483	716	83	139	465	688	45	113	189	348
Off Site Production Facilities (acres)	0	0	0	25	0	0	0	24	0	0	0	19
Production reclamation (acres)	237	399	1,331	1,993	227	382	1,283	1,916	124	311	538	993
Total reclamation (total disturbance) (acres)	274	491	1,764	2,555	262	470	1,700	2,457	153	383	877	1,433
Water use for drilling (1,000s of gallons)	400	1,000	24,900	26,300	383	957	24,000	25,339	312	779	19,500	20,590
Water use for hydraulic fracturing (1,000s of gallons)	8,000	20,000	1,245,000	1,273,000	7,652	19,131	1,200,000	1,226,783	6,231	15,577	975,000	996,807

Activity	Alts C and I				Alt D				Alt E			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	3	9	42	54	16	39	195	249	14	35	42	92
Roads (miles)	5	9	28	42	16	39	65	119	7	18	7	32
Roads (acres)	25	41	137	203	75	189	315	579	34	85	34	154
Well Pads (acres)	7	18	81	106	32	80	373	486	29	73	81	183
Road & Well Pads (acres)	32	59	218	308	108	269	688	1,065	63	158	115	336
Well pads initial reclamation (acres)	6	16	74	96	29	72	339	439	26	65	74	164
Well pads in production (acres)	1	2	7	10	4	9	34	46	3	8	7	19
Pipelines (miles)	6	9	31	46	17	43	72	131	8	19	8	35
Pipelines (acres)	15	25	82	122	45	113	189	348	20	51	21	92
Off Site Production Facilities (acres)	0	0	0	4	0	0	0	19	0	0	0	18
Production reclamation (acres)	40	68	226	339	124	311	538	992	58	145	62	282
Total reclamation (total disturbance) (acres)	47	84	300	434	153	382	877	1,432	84	209	136	446
Water use for drilling (1,000s of gallons)	68	170	4,233	4,471	311	778	19,500	20,589	282	704	4,233	5,218
Water use for hydraulic fracturing (1,000s of gallons)	1,360	3,400	211,650	216,410	6,223	15,558	975,000	996,782	5,631	14,076	211,650	231,357

Activity	Alt F				Alt G				Alt H			
	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total	Explor/ Eval wells (vertical)	Develop wells (vertical)	Develop wells (horizontal)	Total
Number of wells	12	30	156	198	14	36	42	93	11	28	138	177
Roads (miles)	6	15	26	47	7	18	7	32	6	14	23	42
Roads (acres)	29	73	126	229	35	87	34	156	27	67	112	205
Well Pads (acres)	25	63	298	386	30	74	81	185	23	57	264	344
Road & Well Pads (acres)	54	136	424	615	65	162	115	341	49	124	376	549
Well pads initial reclamation (acres)	22	56	271	350	26	66	74	166	20	51	240	311
Well pads in production (acres)	3	7	27	37	3	8	7	19	3	6	24	33
Pipelines (miles)	7	17	29	52	8	20	8	35	6	15	25	46
Pipelines (acres)	18	44	76	137	21	52	21	94	16	40	67	123
Off Site Production Facilities (acres)	0	0	0	15	0	0	0	18	0	0	0	14
Production reclamation (acres)	50	125	229	418	59	148	62	287	45	113	202	374
Total reclamation (total disturbance) (acres)	72	180	500	768	86	214	136	453	66	164	442	685
Water use for drilling (1,000s of gallons)	242	606	15,600	16,449	288	720	4,233	5,240	220	551	13,800	14,571
Water use for hydraulic fracturing (1,000s of gallons)	4,849	12,122	780,000	796,971	5,757	14,392	211,650	231,799	4,405	11,011	690,000	705,416

Basic Oil & Gas Investment and Outputs by Alternative

The federal oil and gas leasing program provides natural gas and other energy minerals needed by people, and provides a source of revenue to federal and local governments. Federal oil and gas leases are issued by competitive sale. A competitive sale may generate federal revenue from a bonus bid, as well as the annual rental fees for the lease acreage. If a lease is drilled and goes into production, the federal government receives a royalty on production. The revenue generated from the federal leases is shared with all the counties on the Forest. The federal government provides the counties 25 percent of all of the revenues from federal leasing (annual rental fees, production royalties, bonus bids). Basic oil & gas investments and the resulting outputs for future federal oil & gas leases on GWNF 100% Federal Mineral Ownership are shown in Table 3D-7. Additional investments may be for such work as geophysical exploration, road and bridge upgrades, gas field maintenance and operations, and reclamation. Similarly, additional outputs would occur as federal revenue from bonus bids and annual lease rentals, State and counties 25% share of these federal revenues. Other outputs may be such items as severance tax revenue to state or counties where applicable, and *Ad valorem* property taxes on production and field equipment.

Table 3D-7. Oil & Gas Investment and Outputs on Future New Federal Oil & Gas Leases on GWNF 100% Federal Mineral Ownership[1]

Activity	RFD	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Oil & Gas Investment[2] (millions $)	$1,698	$1,623	$1,255	$0	$1,255	$93	$933	$95	$788
Natural gas production (MCF)	679,000,000	649,000,000	502,000,000	0	502,000,000	37,000,000	373,000,000	38,000,000	315,000,000
Wellhead value of natural gas production[3] (millions $)	$3,055	$2,921	$2,259	$0	$2,259	$1,67	$1,679	$171	$1,418
Federal revenue[4]: production royalty (millions $)	$382	$365	$282	$0	$282	$21	$210	$21	$177
25% share of federal royalty to States for distribution to counties for schools and roads[4] (millions $)	$95	$91	$71	$0	$71	$5	$52	$5	$44

[1] This table excludes the part of the baseline RFD and the alternatives that do not vary by alternative: 16% of federal surface underlain by private mineral rights (partial or complete mineral interest) and 1% of federal surface in current federal leases.
[2]Based on estimated average cost for completed vertical well of $2.5 million and completed horizontal well of $7.5 million
[3]Based on 15 year average of $4.50/MCF (March 1997-Feb 2012) using U.S. Energy Information Administration (2012) data
[4]Does not include federal revenue from bonus bids and annual lease rental payments

DIRECT, INDIRECT AND CUMULATIVE EFFECTS OF FEDERAL OIL AND GAS LEASING AVAILABILITY

Geologic Resources

Federal oil and gas activities that involve ground disturbance, such as construction of roads, well pads, and pipeline corridors, have the potential to adversely affect geologic resources, such as groundwater, groundwater-dependent ecosystems, springs, caves, sinkholes, karst, unusual landforms, and paleontological resources. All the alternatives with federal oil and gas leasing have the environmental protection requirements contained in federal oil and gas leases, BLM oil and gas regulations, Forest Service oil and gas regulations, State oil and gas regulations, federal laws applicable to NFS lands, and Forest Plan standards. The Forest Plan standards to protect geologic resources are in various sections of the Forest Plan, including Geologic Resources, Geologic Hazards, Water, Soil, Caves and Karstlands, and Indiana Bat Management. Standards under all alternatives provide that the location and design of management activities, including oil and gas activities, will evaluate measures to avoid, minimize, or mitigate adverse effects on geologic resources with identified values (scientific, scenic, paleontological, ecological, recreation, drinking water, groundwater and groundwater dependent ecosystems). The environmental protection requirements would avoid or reduce potential effects on the Forest's geologic resources.

The potential ground-disturbing activities associated with oil and gas activity will be used as an indicator of potential impact on geologic resources (Table 3D-5). Using this indicator, Alternatives C and I have the lowest potential for impact on geologic resources; Alternatives E, G, H, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact on geologic resources.

In regard to karst resources (caves, sinkholes, springs, groundwater), geologic map units indicate 11% of the Forest (about 119,000 acres) have geologic formations containing karst (Figure 3A-1). These geologic map units containing karst (carbonate bedrock) are estimated to encompass 109,308 acres in Virginia and 9,906 acres in West Virginia. Karst areas may be less than 100% of the geologic map unit because other types of bedrock may be present. The Marcellus Shale occurs on about 56% of the Forest (about 592,300 acres) (Figure 3D-2). The geologic map units containing karst (11% of Forest) generally do not overlap with the Marcellus Shale (56% of Forest). The relatively small areas of overlap as well as the environmental protection requirements relating to karst would avoid or reduce potential for adverse effects on karst resources, such as damage to caves. Still, the potential for impact remains, and the greatest vulnerability to groundwater contamination is in karst terrain where spills on the ground surface could seep rapidly into the groundwater system, and where drilling and hydraulic fracturing have potential to affect karst groundwater systems. The karst terrain on or off the Forest could be affected by spills or accidents in the transport of materials to and from the well sites (including transport of flowback fluids to disposal sites off the Forest). Using potential ground-disturbing activities associated with oil and gas activity as an indicator of potential impact on karst, Alternatives C and I have the lowest potential for impact; Alternatives E, G, H, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact on karst. Alternative H has an added protection for karst in that the cave areas identified as Special Geologic Areas are also available only with No Surface Occupancy.

Public scoping concerns about groundwater arose initially in regard to potential use of multi-stage hydraulic fracturing of horizontal wells to develop unconventional gas on future federal oil and gas leases on the Forest. Because the risk to groundwater increases with increasing exposure to the potential hazard, the number of horizontal wells using multi-stage hydraulic fracturing (Table 3D-5) can be used as one indicator of potential hazard and risk to groundwater, Alternatives C, E, G and I would have no multi-stage hydraulic fracturing horizontals wells on future federal oil and gas leases, and so, would have the least impact on groundwater. Alternatives H, F, B and D would have increasing numbers of horizontal wells, and so, an increasing level of potential impact; and Alternative A would have the most horizontal wells and the most potential for impact on groundwater.

Further concerns about groundwater were raised about the use of hydraulic fracturing in any oil and gas well (vertical or horizontal well). In addition, impacts to groundwater can occur not only during the drilling and

hydraulic fracturing process, but also during the life of a well due to development of a leak or break in the subsurface protections (such as casing and cement). Using the number of wells (vertical and horizontal wells) (Table 3D-5) as another indicator of potential hazard and risk to groundwater, Alternatives C and I would have no wells on future federal oil and gas leases, and so, would have the least potential impact on groundwater. Alternatives E, G, H, F, B and D would have increasing numbers of wells, and so, an increase in potential impact; and Alternative A would have the most wells and most potential for impact on groundwater. More analysis on potential effects on groundwater is in Water and Aquatics section.

Geologic Hazards

Geologic hazards are geologic processes or conditions (naturally occurring or altered by humans) that present a risk or potential danger to public safety, infrastructure, and resources. In addition to the types of geologic hazards discussed in Chapter 3 Section A, oil and gas activities add types of geologic hazard specific to oil and gas exploration and development, such as gas blowouts from wells, gas explosion, and gas fires, for example from damaged gas pipelines. Geologic hazards may affect or be affected by oil and gas activities, such as construction of roads, well pads, and pipeline corridors. Oil and gas activities have potential for two types of effects relating to geologic hazards:

Type 1 effect - Oil and gas activities have the potential to increase risk to public safety, infrastructure, and resources by not considering natural geologic hazards in the location, design, operation and maintenance of oil and gas activities. For example, a natural landslide may damage or destroy an access road or a gas pipeline, and injure or kill people. Different geologic settings have different geologic hazards. In karst areas, there are karst geologic hazards, including potential for ground collapse (sinkholes). If siting, design, operation and maintenance of oil and gas activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.

Type 2 effect - Oil and gas activities have the potential to increase risk to public safety, infrastructure and resources by not considering human-induced geologic hazards in the location, design, operation and maintenance of oil and gas activities. Oil and gas activities have the potential to: 1) create human-induced geologic hazards; or 2) trigger or aggravate natural geologic hazards. For example, in karst areas, oil and gas activities have the potential to contaminate groundwater and to trigger or aggravate karst geologic hazards, including potential for ground collapse (sinkholes). Another example, excavation for oil and gas access road on a steep slope can undercut and remove some support from the hillside. In some geologic settings (adverse bedrock structures or weak surficial materials), this undercut and removal of support may lead to failure of the road cut-slope and hillside upslope. Or, construction of a road fill or well pad fill on a steep, geologically unstable slope may lead to a failure of the fill-slope. A fill failure triggered during a heavy rainstorm can transform into a debris flow and travel hundreds or thousands of feet down slope, endangering people and infrastructure far away from the fill failure. If siting, design, and maintenance of oil and gas activities do not consider the geologic setting and potential geologic hazards, then public safety and infrastructure may be inadvertently and unnecessarily put at risk.

Mitigation of these potential impacts under each alternative is a challenge because there is no federal law with specific requirements that federal agencies consider the effects of ground disturbing activities on geologic hazards and associated risks to public safety.

To address the wide range of geologic hazards and to reduce the potential for impacts from oil and gas activities, the alternatives have forestwide standards that provide:

- Locate, design, and maintain trails, roads, other facilities, and management activities to avoid, minimize, or mitigate geologic hazards and potential impact on infrastructure and public safety.
- For ground-disturbing projects on slope gradients of 40% or greater located upslope and within one-half mile of Forest external boundary, conduct a geologic hazard and risk assessment of off-Forest public safety for landslides, including debris flows.
- Site characterization prior to construction on slope gradients of 40% or greater will: 1) identify existing geologic slope stability conditions; 2) evaluate how construction would alter the existing

conditions; and 3) assess potential for slope failures (from cut slopes, fill slopes, disposal sites for excess excavation, and sidecast material).

The potential ground-disturbing activities associated with oil and gas activity (Table 3D-5) will be used as an indicator of potential impact on geologic hazards. Using this indicator, Alternatives C and I have the lowest potential for impact on geologic hazards; Alternatives E, G, H, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for impact on geologic hazards.

The potential future oil and gas activities from existing federal leases and private mineral rights are the same for each alternative, and so, the added potential effects on geologic resources and geologic hazards are the same for each alternative. Adding these effects to the effects from future oil and gas activities from future federal leases on 100% federal mineral ownership gives the total effects from the Forest's future oil and gas activities. Using potential ground-disturbing activities associated with oil and gas activity (Table 3D-6) as an indicator of potential effects on geologic resources including karst resources and on geologic hazards, Alternatives C and I have the lowest potential for cumulative impacts; Alternatives E, G, H, F, D and B have increasing levels of potential impact; and Alternative A has the most potential for cumulative impacts. In regard to effects on groundwater from oil and gas activities, using horizontal wells with multi-stage hydraulic fracturing as one indicator of potential impact on groundwater, Alternatives C, E, G and I would have the least impact; Alternatives H, F, B and D would have increasing levels of potential impact; and Alternative A would have the most potential for impact on groundwater. Using vertical and horizontal wells as another indicator of potential impact on groundwater, Alternatives C and I would have the least impact on groundwater; Alternatives E, G, H, F, B and D would have increasing levels of potential impact; and Alternative A would have the most potential for impact on groundwater.

Considering the oil and gas activities along with other Forest management activities (timber, recreation, etc.), the cumulative impact on geologic resources and geologic hazards is the combination of the impacts discussed in Chapter 3 Section A with the impacts discussed above.

Soils

Oil and gas lease development is likely to affect soils on a long-term basis with displacement and compaction associated with roads and well pad development and is mainly caused by the blading of these areas. Pipeline installations are likely to impact soils on a short-term basis due to the replacement of displaced soil back into the trench. Some pipeline installations will parallel roads. The soil has remained onsite and will recover with vegetative cover. Disturbed soils are prone to erosion when vegetation is removed. Erosion control plans will be implemented.

Soils could also be affected by localized spills of fluids used during the drilling process, which could sterilize the soil and affect soil productivity. Operation plans will require drilling fluids, muds and cuttings to be contained in lined ponds and removed after use. Fracking fluids will be contained in a closed loop system and will be disposed off-site.

Estimates of the effects to long-term soil productivity and how extensive they could be are shown below. A threshold for a significant impact to soil productivity will be a fifteen percent reduction in productivity across the areas on the Forest that could be affected by oil and gas lease development (activity area). When long-term soil productivity is reduced on fifteen percent or more of the activity area by any alternative, then this would be a significant impact to the soil resource and would not be in compliance with the laws guiding FS policy on protecting soil productivity. By identifying impacts to soil productivity and minimizing these impacts to small areas, we can protect the soil's ability to function as an important part of the surrounding ecosystem.

Activity areas are the areas on the Forest where oil and gas exploration and development could occur. Each alternative has a different sized activity area because alternatives vary by management area and prescription allocations. The size of the different management areas on the forest changes by alternative. In each alternative we have subtracted the acres on the Forest that will not be impacted by oil and gas development. The Activity Area for each alternative is used to compare with the total acres of long-term effect to soil productivity from oil and gas development and therefore determine the extent of the effects to soil productivity

for each alternative. In this way we can estimate the effects to the soil resource from oil and gas lease development across the Forest.

Table 3D-8. Oil and Gas Activity Areas by Alternative, thousands of acres

Category	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Total Forest acres	1,066	1,066	1,066	1,066	1,066	1,066	1,066	1,066
No development expected [1]	95	275	968	277	352	451	336	736
Total Activity Area, acres of possible development	971	791	98 [2]	789	714	615	730	330

[1] No development assumed in areas designated: No Surface Occupancy, Administratively Unavailable, Legally Unavailable and Administratively Available Decision Deferred, using Table 3D-2, Final EIS, Chapt. 3.

[2] Private mineral rights on these acres are considered possible for development.

The table below displays the estimated long-term effects to soil productivity in the areas where leasing and development will most likely occur. Long-term effects will be due to well site and road construction.

Table 3D-9. Estimated Long-Term Effects to Soil Productivity from RFD Oil and Gas Lease Development by Alternative

Category	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Acres of Long-Term Productivity Affected[1]	1744	1065	308	1065	336	615	341	549
Activity Area, acres	971,000	791,000	97,615	789,000	714,000	615,000	730,000	330,000
Percent of Area Affected Long-Term[2]	0.2%	0.1%	0.3%	0.1%	0.05%	0.1%	0.05%	0.2%

[1] Acres in Roads and Well Pads.

[2] Percent of the area most likely to be developed or activity area.

Cumulative effects add in wells and roads already constructed on the Forest for oil and gas development.

As of Feb 2013, federal oil and gas leases were in effect on about 1% of the Forest (10,412 acres). Oil and gas exploration and development on existing federal oil and gas leases can occur regardless of which alternative is chosen.

The estimated cumulative oil and gas development from projected federal and private oil & gas lease activity on GWNF for each Alternative is shown below along with cumulative effects to soils from other management activity, by alternative.

Table 3D-10. Total Cumulative Long-Term Effects to Soil Productivity from Oil and Gas Lease Development and Proposed Forest Plan Alternatives, acres

Category	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Acres of Existing Impacts from Oil and Gas Development [1]	10	10	10	10	10	10	10	10	10
Oil and Gas Lease Development Effects, Acres [2]	1,744	1,065	308	1,065	336	615	341	549	308
Total Cumulative Effects from All Other Forest Plan Activity, Acres [3]	5,376	5,106 – 5,436	4,295	5,674 – 6,194	5,041-5,321	4,883 – 5,123	5,041 – 5,371	5,041 – 5,371	5,041 – 5,371
Total Cumulative Effect on Forest Long Term Soil Productivity, Acres	7,130	6,181 – 6,511	4,613	6,749 – 7,269	5,387-5,667	5,508 – 5,748	5,392 – 5,722	5,600 – 5,930	5,359 – 5,689
Percentage of Activity Area with Soil Productivity Impacts ☐	0.7% of 1,021,551 acres	0.6% of 1,002,447 acres	0.7% of 636,140 acres	0.7% of 1,008,299 acres	0.5-0.6% of 998,601 acres	0.6% of 910,782 acres	0.5-0.6% of 1,002,612 acres	0.6% of 995,202 acres	0.5-0.6% of 995,202 acres

[1] Existing oil and gas long-term effects result from 5 existing well sites. Existing roads for oil and gas development are included in the effects of FS system roads, Table 3A4-3. Exploration/Evaluation Well Pad (vertical well) - (300'x300' pad): 2.07 acres per pad used for the five existing wells.
[2] Area in roads and well pads
[3] Adjusted Cumulative Long Term Effects from Table 3A4-3.
[4]Activity Area is the area on the Forest where there is potential for soil disturbance, taken from Table 3A4-1.

Estimated cumulative effects from RFD oil and gas development and proposed Forest Plan management activities are similar for all alternatives. At least 99% of the Forest's soil productivity will be maintained.

Short-term effects from compaction and erosion will be minimized through implementation of the site-specific erosion and sediment control plans developed for all construction areas. A Spill Prevention Control and Countermeasures Plan is prepared for each site to minimize the possibility and impacts from spills associated with oil and gas development. Overall, cumulative long-term effects to soil productivity from oil and gas on the George Washington NF is less than one percent of the activity area considered for each alternative. Alternatives C and I has the least acres impacted, with Alternative B having the most.

Air Quality

The George Washington National Forest is assessing the environmental consequences of leasing natural gas exploration and production rights on the Forest, under a variety of Alternatives. The primary criteria pollutant emissions from development of natural gas wells are nitrogen oxides (NO_x) and volatile organic compounds (VOC). These pollutants combine in the presence of sunlight to form ozone, a regulated pollutant that affects

human health, and vegetation. The purpose of this analysis is to examine potential air quality impacts of emissions from the proposed activities.

Air quality impacts from development of a natural gas field can be divided into two categories: construction of well sites and production/operation of the wells. These activities differ in that the construction phase is relatively short, while the production phase will persist as long as the well continues to produce gas.

Construction Emissions: Construction emissions include the pollutant emissions from well pad development, which involves three separate, sequential activities: 1) Clearing, grading and construction of the road that connects the existing access road to the well pad site. These activities are sources of fugitive dust emissions from the construction traffic over unpaved roads, and tailpipe emissions from the construction traffic. 2) Rig-up, drilling and rig-down. These activities consist of bringing equipment and supplies by truck to the well site, drilling a hole to the desired depth, and removing the drilling equipment. Pollutant emissions from this phase of activity include particulates from the traffic on unpaved roads, tailpipe emissions from trucks, and exhaust emissions from the diesel powered drilling engines. 3) Completion and testing involves running pipe into the borehole and flaring small quantities of gas at the surface to evaluate productivity of the well. Pollutant emissions that occur during completion and testing include road dust from truck traffic, tailpipe emissions from the trucks, and products of combustion from flaring natural gas. It was assumed that each well would require construction of a separate well pad.

Production Emissions: Gas produced from leased wells on the Forest will be collected and piped to a compressor station located on private land. The main source of emissions from the production phase will be from fugitive equipment emissions. Lesser emissions come from the heater-separator that is designed to separate liquids from the gas stream. Heat comes from burning some of the methane produced from the well.

The emission rates for construction and production activities have been taken from a Bureau of Land Management report "Environmental Assessment: Cooper Reservoir Natural Gas Development Project - Cumulative Air Quality Impact Analysis, May 1998". The Cooper Reservoir Project activities were similar to what would occur in gas field development in southwestern Virginia, which made it possible to use the pre-calculated, construction phase emissions for this analysis. Activities were of similar duration, similar equipment was used, and both projects involved "sweet" gas. Sweet gas wells do not produce hydrogen sulfide gas during flaring.

Analysis: Although the Reasonably Foreseeable Development report by BLM indicates that only a portion of the total wells will be constructed each year, this analysis assumed that construction and production for all wells would occur in one year. This approach provides a “worst case” assessment of potential impacts on air quality. In reality, all development scenarios would produce impacts less than presented here.

Each Alternative has a specified maximum number of wells that could be put into production over the next 15 years. Nitrogen oxide and volatile organic compound emissions from construction and production are calculated and compared between Alternatives for the “Direct/Indirect Effects” analysis. Future emissions from private wells on national forest system lands are added to the emissions from the Direct/Indirect effects analysis to assess "Cumulative Effects". Projected emissions are then compared to the current emission inventory (existing area and point sources of pollution, EPA 2005) for a ten-county analysis area to estimate the future potential effect on air quality. The analysis area includes counties with underlying Marcellus shale: Alleghany, Augusta, Bath, Botetourt, Highland, Rockbridge and Rockingham in Virginia; and Hampshire, Hardy and Pendleton in West Virginia.

Direct/Indirect Effects: The direct effect on air quality of leasing national forest land for gas development will be to increase volatile organic compounds and nitrogen oxides in the atmosphere by a very small amount (Table 3D-11). Maximum annual emissions from “leased wells” would contribute 99 tons per year of VOC; less than 0.4% of current emissions in the analysis area (20,316 tons). Nitrogen oxide emissions are similar; maximum of 89 tons per year which is only 0.39% of current emissions (22,838 tons).

Table 3D-11. Maximum Estimated Annual Air Pollution Emissions from Projected Gas Well Development on the GWNF, tons

Alternative	Direct Effects		Cumulative Effects	
	Volatile Organic Compounds	Nitrogen Oxide	Volatile Organic Compounds	Nitrogen Oxide
A	81	89	99	108
B	63	69	80	88
C and I	0	0	17	19
D	63	69	80	88
E	12	13	29	32
F	46	51	64	70
G	12	13	30	32
H	39	43	57	62
BLM RFD	85	93	102	112
Current Emissions in Tons (EPA 2005 Emissions Inventory)			20,316	22,838

There are differences in air pollution emissions between some of the alternatives, but in all cases emissions are such a small portion of the overall pollution load that all alternatives would have very little effect on air quality.

These estimates of volatile organic compounds are likely high since they do not take into account the new regulations from EPA. On April 17, 2012, the U.S. Environmental Protection Agency (EPA) issued regulations to reduce air pollution from natural gas wells that are hydraulically fractured. A key component of the final rules is expected to yield a nearly 95 percent reduction in VOCs emitted from more than 11,000 new hydraulically fractured gas wells each year. This significant reduction would be accomplished primarily through the use of "green completion" -- to capture natural gas that currently escapes to the air. In a green completion, special equipment separates gas and liquid hydrocarbons from the flowback that comes from the well as it is being prepared for production. The gas and hydrocarbons can then be treated and used or sold, avoiding the waste of natural resources that cannot be renewed.

The VOC emission reductions from wells, combined with reductions from storage tanks and other equipment, are expected to help reduce ground-level ozone in areas where oil and gas production occurs. In addition, the reductions would yield a significant environmental co-benefit by reducing methane emissions from new and modified wells. Methane, the primary constituent of natural gas, is a potent greenhouse gas – more than 20 times as potent as carbon dioxide when emitted directly to the atmosphere. The final rules also would protect against potential cancer risks from emissions of several air toxics, including benzene.

Cumulative Effects: The cumulative effects air analysis included emissions from 1) wells that will be developed from existing leasing rights on national forest land, 2) private-rights wells developed on national forest land, and 3) wells projected for the various Alternatives. Projected emissions from all wells that could be developed in the ten-county area are displayed in Table 3D-9 under "Cumulative Effects". Emissions from all projected development would equal less than 1% of current inventory of VOC and NO_x emissions. Both of these pollutants contribute to the formation of ozone, a criteria pollutant monitored by state air regulators. It is unlikely that the emissions from any of the projected Alternatives would affect ozone attainment status at monitors in the region because the additional emissions are such a small component of overall emissions.

For general information on air quality regulations and current air quality on the Forest see the Affected Environment: Air section of the EIS.

Water Resources and Aquatic Species

The Reasonably Foreseeable Development (RFD) of federal oil and gas on the GWNF is concentrated in the Marcellus shale formation, thus, this analysis will concentrate on potential development of that formation. This includes both vertical and horizontal well development. Horizontal well development has not yet been utilized on the GWNF. To evaluate and develop the Marcellus Shale for natural gas production, horizontal wells will undergo a stimulation process known as hydraulic fracturing, which functions to release gas embedded in shale deep below the surface. In addition, a well may be re-stimulated every five years after the initial fracturing. It is estimated that it takes up to 3-5 million gallons of water per hydraulic fracturing event for each well (Harper 2008) and one drilling site could contain several wells. Some references suggest that up to 8 million gallons of water may be needed per treatment. Flowback water is the fluid that is recovered from the well following hydraulic fracturing. Gelling agents, surfactants and chlorides are identified as the flowback water components of greatest environmental concern. Other flow back components can include other dissolved solids, metals, biocides, lubricants, organics and radionuclides. The RFD estimated 3 wells could be drilled per pad. The following are issues related to water resources and aquatic species and habitat:

- Water withdrawals
- Surface water and groundwater contamination
- Non-point source pollution from ground disturbing activities

The following indicators will be used to reflect the potential risk to watershed, riparian and aquatic resources and the differences between alternatives.

- Percent Marcellus shale on GWNF and private land by watershed, associated with TESLR (Threatened, Endangered, Sensitive and Locally Rare)/MIS (Management Indicator Species)/SMC (Species of Management Concern) aquatic species
- Miles of perennial, intermittent, and trout streams on the GWNF underlain by Marcellus shale
- Percent Marcellus shale by public water supply watershed
- Percent Marcellus shale by source water watershed (applicable to Alternative C)
- Number of potential wells, acres of disturbed areas, and water use by alternative

There are 592,300 acres of Marcellus shale under the Forest land (55.6% of land status). About 16% of the Forest is in outstanding or reserved mineral rights, with 58% of that in Marcellus shale. Only 1 % of the Forest (10,243 acres) is under existing federal oil and gas lease, all of which is within the Marcellus shale formation. Table 3D-12 lists the percent Marcellus shale found in each 5th level HUC watershed, along with the number of aquatic TESLR/MIS/SMC species by watershed. Columns 5-6 indicate the acres or percent of private subsurface ownership on the GWNF, while column 7 includes private land, since those are areas of limited or no Forest Service control. See Appendix J for a table of the complete list of species by watershed.

Table 3D-12. Marcellus Shale and Number of Aquatic TESLR/MIS/SMC by Watershed*

Watershed	Marcellus Acres on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on NF & Private land	Acres of Marcellus in private sub-surface on GWNF	% of watershed, Marcellus in private sub-surface on GWNF	Marcellus % of watershed: private, plus private sub-surface on GWNF	Number of aquatic TESLR/MIS/SMC
North Fk South Br Potomac	10,384	5.1%	71.3%			66.2%	21
South Fk South Br Potomac	55,525	30.1%	90.5%	12,393	6.7%	67.1%	2
Cacapon River	5,484	2.1%	66.9%	3,964	1.5%	66.3%	3
Middle River	22,543	9.4%	11.0%	2,777	1.2%	2.8%	1
Dry River-North River	110,980	58.9%	67.8%	32,557	17.3%	26.2%	4
Naked Cr-South Fk Shenandoah	1,331	0.6%	0.9%	1,026	0.5%	0.8%	5
Shoemaker R-N Fk Shenandoah	61,945	46.5%	87.8%	26,382	19.8%	61.1%	3
Smith Cr-North Fk Shenandoah	333	0.2%	5.4%			5.2%	4
Stony Cr-North Fk Shenandoah	4,906	2.2%	20.2%	1,394	0.6%	18.6%	7
Cedar Creek	422	0.4%	32.7%			32.3%	3
Dunlap Creek	37,679	34.8%	73.6%	707	0.7%	39.5%	2
Potts Creek	12,529	11.3%	47.8%			36.5%	7
Back Creek-Jackson River	55,586	25.2%	45.0%	3,999	1.8%	21.6%	5
Wilson Creek-Jackson River	22,436	16.2%	44.7%	1,152	0.8%	29.3%	8
Cowpasture River	95,086	42.0%	71.9%	10,077	4.5%	34.4%	11
Catawba Creek-James River	6,955	3.3%	22.1%	1,298	0.6%	19.4%	7
Craig Creek	1,259	0.5%	62.1%			61.6%	11
Calfpasture River	69,850	46.3%	72.5%	1,539	1.0%	27.2%	7
Little Calfpasture River	14,974	28.0%	65.2%			37.2%	1

*Birds and non-TE plants were not included in this analysis because species occurrence locations were not readily available in GIS format.

Looking at stream type underlain by Marcellus shale on the GWNF; there are 792 miles of perennial streams, 1,596 miles of intermittent streams, and 426 miles of trout water (VDGIF 2010a).

Table 3D-13 lists the acres and percentages of Marcellus shale in public water supply watersheds, by ownership pattern. Table 3D-14 shows the acres and percentages of Marcellus shale in the source water watersheds used in Alternative C.

Table 3D-13. Marcellus Shale by Public Water Supply Watershed

Public Water Supply Watershed	Acres of Marcellus on GWNF	Marcellus % of watershed on GWNF	Marcellus % of watershed on GWNF & Private land	Acres of Marcellus in private sub-surface on GWNF	% of watershed, Marcellus in private sub-surface on GWNF	Marcellus % of watershed: private, plus private sub-surface on GWNF
North Fork Shenandoah River-Cedar Creek	402	0.4%	32.0%			31.5%
Dry River and Skidmore Fork	19,959	91.8%	100.0%	7,623	35.1%	43.3%
North River	16,699	100.0%	100.0%	2,270	13.6%	13.6%
Smith Creek	457	5.1%	5.7%	64	0.7%	1.3%
Jackson River	17	0.4%	69.4%			68.9%

Table 3D-14. Private Marcellus Shale by Source Water Watersheds used in Alternatives C

Source Water Watershed	Acres of Marcellus in private sub-surface on GWNF	% of watershed, Marcellus in private sub-surface on GWNF	Marcellus % of watershed: private, plus private sub-surface on GWNF
Painter Run-Stony Creek	41	0.1%	3.5%
Crab Run	2,722	14.9%	82.6%
Runion Creek-North Fork Shenandoah River	938	4.6%	62.6%
German River	6,083	30.5%	81.5%
Riles Run-Stony Creek	574	1.7%	56.8%
Little Dry River	6,251	31.1%	51.7%
Capon Run-North Fork Shenandoah River	1,812	5.8%	39.3%
Yellow Spring Run-Stony Creek	762	6.9%	32.1%
Shoemaker River	8,548	36.5%	66.5%
Honey Run-Dry River	68	0.7%	16.1%
Skidmore Fork-Dry River	10,273	41.3%	56.5%
Thorny Branch-North River	3,362	11.8%	26.2%
Black Run-Dry River	10,121	46.3%	53.5%
Little River	2,573	15.8%	18.4%
Briery Branch	659	2.1%	11.7%
Skidmore Fork-North River	4,559	18.0%	18.4%
Muddy Creek	951	4.7%	17.5%
Chair Draft-Calfpasture River	1,341	9.3%	24.4%
Hamilton Branch	192	1.6%	19.5%

The RFD estimates a total of 319 wells within the Marcellus formation (20 vertical exploration wells, 50 vertical development wells, and 249 horizontal development wells). Associated activities include: 246 miles of roads, 621 acres of well pads, 271 miles of pipeline, 26,300,000 gallons of water for drilling, and 1,273,000,000 gallons of water for fracturing. As previously stated, water withdrawals, ground and surface water contamination, and non-point source pollution from ground disturbing activities are issues of concern in relation to water resources and aquatic species.

General Effects from Water Withdrawals

Water for hydraulic fracturing will need to be trucked in, or withdrawn from nearby streams or aquifers. Without proper controls on the rate, timing and location of withdrawals, stream flow modifications could result in negative impacts to a stream's best uses, including but not limited to the aquatic ecosystem, downstream riverine and riparian resources, wetlands, and aquifer supplies. See *Appendix I - Analysis of Concerns and Risks of Horizontal Drilling and Hydraulic Fracturing*, for additional concerns regarding water withdrawals.

Impacts to Aquatic Ecosystems

Aquatic ecosystems could be adversely impacted by:

- changes to water quality or quantity;
- insufficient stream flow for aquatic biota or to maintain stream habitat; or
- the actual water withdrawal infrastructure.

Many small headwater streams on the Forest undergo severe flow reductions during the summer and early fall, making them very susceptible to further water reductions. Drawing production water from these streams could cause reductions in fish and other aquatic organism populations or damage them permanently (Vokoun and Kanno 2009). Similarly, massive withdrawals of groundwater in these headwater watersheds could adversely affect surface water flow (PSU 2009; NYDEC 2009).

Seasonally, unmitigated withdrawals could adversely impact fish and wildlife health due to exposure to unsuitable water temperature and dissolved oxygen concentrations. It could also affect downstream dischargers whose effluent limits are controlled by the stream's flow rate. Water quality could be degraded and exert greater impacts on natural aquatic habitat if existing pollutants from point sources (e.g. discharge pipes) and non-point sources (e.g. runoff from farms and paved surfaces) are not sufficiently diluted or become concentrated.

Improperly installed water withdrawal structures can result in the entrainment of aquatic organisms, which can remove any/all life stages of fish and macroinvertebrates from their natural habitats as they are withdrawn with water. To avoid adverse impacts to aquatic biota from entrainment, intake pipes can be screened to prevent entry into the pipe. Additionally, the loss of biota that becomes trapped on intake screens, referred to as impingement, can be minimized by properly sizing the intake to reduce the flow velocity through the screens. Transporting water from the water withdrawal location for use off-site can transfer invasive species from one waterbody to another via trucks, hoses, pipelines, and other equipment. Screening of the intakes can minimize this transfer; however additional site-specific mitigation considerations may be necessary.

Impacts to Downstream Wetlands

The existence and sustainability of wetland habitats directly depend on the presence of water at or near the surface of the soil. The functioning of a wetland is driven by the inflow and outflow of surface water and/or groundwater. As a result, withdrawal of surface water or groundwater for high volume hydraulic fracturing could impact wetland resources. These potential impacts depend on the amount of water within the wetland, the amount of water withdrawn from the catchment area of the wetland, and the dynamics of water flowing into and out of the wetland. Even small changes in the hydrology of the wetland can have significant impacts on the wetland plant community and on the animals that depend on the wetland. It is important to preserve the hydrologic conditions and to understand the surface water and groundwater interaction to protect wetland areas.

Aquifer Depletion

The primary concern regarding groundwater withdrawal is aquifer depletion that could affect other uses, including nearby public and private water supply wells. This includes cumulative impacts from numerous groundwater withdrawals and potential aquifer depletion from the incremental increase in withdrawals if groundwater supplies are used for hydraulic fracturing. Aquifer depletion may also result in aquifer compaction which can result in localized ground subsidence. Aquifer depletion can occur in both confined and unconfined aquifers.

The depletion of an aquifer and a corresponding decline in the groundwater level can occur when a well, or wells in an aquifer are pumped at a rate in excess of the recharge rate to the aquifer. Essentially, surface water and groundwater are one continuous resource; therefore, it also is possible that aquifer depletion can occur if an excessive volume of water is removed from a surface water body that recharges an aquifer. Such an action would result in a reduction of recharge which could potentially deplete an aquifer.

Aquifer depletion can lead to reduced discharge of groundwater to streams and lakes, reduced water availability in wetland areas, and corresponding impacts to aquatic organisms that depend on these habitats. Flowing rivers and streams are merely a surface manifestation of what is flowing through the shallow soils and rocks. Groundwater wells impact surface water flows by intercepting groundwater that otherwise would enter a stream. In fact, many headwater streams rely entirely on groundwater to provide flows in the hot summer months. It is therefore important to understand the hydrologic relationship between surface water, groundwater, and wetlands within a watershed to appropriately manage rates and quantities of water withdrawal.

Depletion of both groundwater and surface water can occur when water withdrawals are transported out of the basin from which they originated. These transfers break the natural hydrologic cycle, since the transported water never makes it downstream nor returns to the original watershed to help recharge the aquifer. Without the natural flow regime, including seasonal high flows, stream channel and riparian habitats critical for maintaining the aquatic biota of the stream may be adversely impacted. Surface and subsurface sources of public and private water supply may be reduced.

General Effects from Surface Water and Groundwater Contamination

See *Appendix I - Analysis of Concerns and Risks of Horizontal Drilling and Hydraulic Fracturing*, for additional concerns regarding, and specific examples of surface and groundwater contamination.

Surface Spills and Releases at the Well Pad

Contamination of surface water bodies and groundwater resources during well drilling could occur as a result of failure to maintain stormwater controls, ineffective site management and surface and subsurface fluid containment practices, poor casing construction, or accidental spills and releases. Surface spills would involve materials and fluids present at the site during the drilling phase. Spills or releases can occur as a result of tank ruptures, equipment or surface impoundment failures, overfills, vandalism, accidents (including vehicle collisions), ground fires, or improper operations. Spilled, leaked or released fluids could flow to a surface water body or infiltrate the ground, reaching subsurface soils and aquifers. Pit leakage or failure could also involve well fluids. The greater intensity and duration of surface activities associated with well pads with multiple wells increases the odds of an accidental spill, pit leak or pit failure if mitigation measures are not sufficiently durable. Concerns are heightened if on-site pits for handling drilling fluids are located in primary and principal aquifer areas, or are constructed on the filled portion of a cut-and-filled well pad.

Hydraulic Fracturing Additives and Flowback Water

As with the drilling phase, contamination of surface water bodies and groundwater resources during well stimulation could occur as a result of failure to maintain stormwater controls, ineffective site management and surface and subsurface fluid containment practices, poor well construction and grouting, or accidental spills and releases. These issues are acknowledged here because of the larger volumes of fluids and materials to be managed for high-volume hydraulic fracturing.

Flowback water is the fluid that is recovered from the well following hydraulic fracturing. Gelling agents, surfactants and chlorides are identified as the flowback water components of greatest environmental concern. Other flow back components can include other dissolved solids, metals, biocides, lubricants, organics and radionuclides. The exact characteristics and quantities of components in flowback water will vary by location. The additives are proprietary information and unavailable for analysis.

Opportunities for spills, leaks, operational errors, and pit or surface impoundment failures during the flowback water recovery stage are the same as they are during the prior stages with the additional potential of releases from:

- hoses or pipes used to convey flowback water to tanks, an on-site pit, a centralized surface impoundment, or a tanker truck for transportation to a treatment or disposal site; and
- tank leakage or failure of a pit or surface impoundment to effectively contain fluid.

As much as 60–80% of the hydraulic fracturing water can return to the surface (Staaf and Masur 2009) contaminated with tens of thousands of pounds of chemicals, salt, and sand. This wastewater is stored in holding ponds, potentially adjacent to perennial or intermittent stream channels and is subject to overflow, leakage, or spillage. Contact with adjacent waterways could cause fish kills or affect entire food webs and could contaminate drinking water sources. All of these streams have floodplains and, often, a complex series of dry flood channels that are sensitive to disturbances in these areas. The majority of incidents that lead to surface water contamination result from spills and leakage during the transfer and draining of these pits (NYDEC 2009).

Contaminated flowback water that is trucked off the drilling site to local wastewater treatment plants may not be able to be effectively treated (Soeder and Kappel 2009; Levy and Smith 2010) and, in fact, might render the plant useless (by killing off active media). Sand, salt, and a mixture of biocides, surfactants, lubricants, and solvents may pass through these treatment plants directly into larger rivers. Many of these rivers are already under stress from other contaminants and this would potentially add to pollution troubles (VDGIF 2010).

Land application of contaminated flowback water and solids have been known to sterilize soils and kill forest plots. At the very least, flowback water is known to contain high levels of chloride; chlorides have a number of biological and non-biological effects. Chloride ions pass readily through soil and will eventually enter surface water. Because chloride moves through soil at the same rate as water it shares the same hydrologic cycle as water. This means chloride deposited on soil's surface can also enter ground water (Environment Canada 2001). Sodium chloride is inhibiting to soil bacteria at about 50 mg/l. High concentrations of chloride will damage or kill leaves or buds when delivered as a spray. Concentrations first will affect sensitive vegetation and trees. High enough concentrations will sterilize soil and prohibit any growth (Siegal 2007).

Millions of gallons of contaminated flowback water can remain in the ground during and after production. Extra steel and concrete casing is required in wells to protect groundwater; however, corrosive agents used in slickwater frac could erode casings and contaminate entire aquifers. Many of these shale deposits are adjacent to limestone geology, thus residual frac water under pressure could find its way into groundwater supplies.

Fuel oil, surfactants, and biocides are also used in slickwater frac and this gelatinous mixture has the potential to fill fissures underground and create pollution issues. Although it is surmised that these compounds comprise only a small fraction of the fracturing fluid, it becomes additive when millions of gallons of water are pumped into the ground. This could add up to hundreds of pounds of chemicals over the production life of a well (Soeder and Kappel 2009).

Concentrated solids, contaminated with radioactive waste (i.e. radium) are often extracted from the ground after being used to fracture the shale. Some frac water in New York State exceeded the EPA safety standards for radioactivity. However, more study is needed to determine the potential impacts of radioactive materials on aquatic organisms (Sumi 2008; Rabb 2010).

Centralized Flowback Water Surface Impoundments

Use of centralized surface impoundments and flowback water pipelines as part of a flowback water dilution and reuse system has environmental benefits, including reduced demand for fresh water, reduced truck traffic and reduced need for flowback water treatment and disposal. However, any proposal for their use requires that the potential impacts be recognized and mitigated through proper design, construction, operation, closure and regulatory oversight.

- Potential soil, wetland, surface water and groundwater contamination from spills, leaks or other failure of the impoundment to effectively contain fluid. This includes problems associated with liner or construction defects, unstable ballast or operations-related liner damage.
- Potential soil, wetland, surface water and groundwater contamination from spills or leaks of hoses or pipes used to convey flowback water to or from the centralized surface impoundment.
- Potential for personal injury, property damage or natural resource damage similar to that from dam failure if a breach occurs.
- Transfer of invasive plant species by machinery and equipment used to remove vegetation and soil.
- Consumption by waterfowl and other wildlife of contaminated plant material on the inside slopes of the impoundment.

General Effects from Non-point Source Pollution from Ground Disturbing Activities

See *Appendix I - Analysis of Concerns and Risks of Horizontal Drilling and Hydraulic Fracturing*, for additional concerns regarding, and specific examples of non-point source pollution from ground disturbing activities.

All phases of natural gas well development, from initial land clearing for access roads, equipment staging areas and well pads, to drilling and fracturing operations, production and final reclamation, have the potential to cause water resource impacts during rain and snow melt events if stormwater is not properly managed.

Initial land clearing exposes soil to erosion and more rapid runoff. Construction equipment is a potential source of contamination from such things as hydraulic, fuel and lubricating fluids. Equipment and any materials that are spilled, including additive chemicals and fuel, are exposed to rainfall, so that contaminants may be conveyed off-site during rain events if they are not properly contained. Steep access roads, well pads on hill slopes, and well pads constructed by cut-and-fill operations pose particular challenges, especially if an on-site drilling pit is proposed.

A production site, including access roads, is also a potential source of stormwater runoff impacts because its hydrological characteristics may be substantially different from the pre-developed condition. There is a greater potential for stormwater impacts from a larger well pad during the production phase, compared with a smaller well pad for a single vertical well.

Each drilling pad occupies 2-6 acres of ground, not including roads and pipelines. Several pads can occupy one site, creating the potential for a significant volume of non-point runoff (NYDEC 2009). Fugitive dust may be problematic for adjacent waterways.

Cumulative Impacts

Cumulative impacts are the effects of two or more single projects considered together. Adverse cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time. Since gas production declines rapidly after the first year of well stimulation, the potential to re-stimulate the gas-producing geologic formation with another hydraulic fracturing may be considered. This second

hydraulic fracturing would use the same well and may use similar volumes of water as the first hydraulic fracturing, multiplying effects through time. Cumulative impacts will be discussed from two perspectives:

1) Site-Specific cumulative impacts beyond those previously discussed resulting from multi-well pads and

2) Regional impacts which may be experienced as a result of gas development.

Site-Specific Cumulative Impacts

The potential for site-specific cumulative impacts as a result of multi-well pads, while real, is easily quantified and can be adequately addressed during the application review process (NYDEC 2009). General areas of concern with regard to water use, ground disturbance, and contamination issues are the same as those of individual well pads. While the pads may be slightly larger than those used for single wells, the significant impacts are due to the cumulative time and trucking necessary to drill and stimulate each individual well.

In relation to non-point source pollution and surface water contamination, maintenance of the roads and accidental vehicular spills is a concern because of the number and size of the trucks used to transport and deliver equipment and supplies. A horizontal well takes four to five weeks of 24-hour-per-day drilling with an additional three to five days for the hydraulic fracture. This duration will be required for each well, with industry indicating that it is common for three wells to be drilled on a multi-well pad. Typically, one or two wells are drilled and stimulated and then the equipment is removed. If the well(s) are economically viable, the equipment is brought back and the remaining wells drilled and stimulated. Current regulations require that all wells on a multi-well pad be drilled within three years of starting the first well. As industry gains confidence in the production of the play, there is the possibility that all wells on a pad would be drilled, stimulated and completed consecutively.

The trucking requirements for rigging and equipment will not be significantly greater than for a single well pad, especially if all wells are drilled consecutively. Water and materials requirements, however, will greatly increase the amount of trucking to a multi-well pad compared to a single well pad. The NYDEC estimated truck trips per an eight well multi-well pad; those estimates were scaled back to 3 wells per pad and are as follows:

- Drill Pad and Road Construction Equipment 10 – 25 Truckloads
- Drilling Rig 20 Truckloads
- Drilling Fluid and Materials 100-200 Truckloads
- Drilling Equipment (casing, drill pipe, etc.) 100-200 Truckloads
- Completion Rig 15 Truckloads
- Completion Fluid and Materials 40-80 Truckloads
- Completion Equipment – (pipe, wellhead) 5 Truckloads
- Hydraulic Fracture Equipment (pump trucks, tanks) 150-200 Truckloads
- Hydraulic Fracture Water 1,600 – 2,400 Tanker Trucks
- Hydraulic Fracture Sand 80 – 100 Trucks
- Flow Back Water Removal 800 – 1,200 Tanker Trucks

Total estimates are 2,920–4,445 truck trips per 3 well pad. As can be seen, the vast majority of trucking is involved in delivering water and removing flow back. Multiple wells in the same location provide the potential to reduce this amount of trucking by reusing flow back water for the stimulation of other wells on the same pad. The centralized location of water impoundments may also make it economically viable to transport water via pipeline or rail in certain instances.

In the production phase, the operations at multi-well pads include a small amount of equipment, including valves, meters, dehydrators and tanks remaining on site, which may be slightly larger than what is used for single wells but is still minor. The reclamation procedures are the same as for single well pads, however, there will be more area left for production equipment and activities. It is anticipated that a multi-well pad will require up to three acres compared to one acre or less for a single well pad.

Regional Cumulative Impacts

The level of impact on a regional basis will be determined by the amount of development and the rate at which it occurs. Accurately estimating this is inherently difficult due to the wide and variable range of the resource, rig, equipment and crew availability, permitting and oversight capacity, leasing, and most importantly, economic factors. This holds true regardless of the type of drilling and stimulation utilized. In other plays around the country, development has occurred in a sequential manner over years with development activity concentrated in one area then moving on with previously drilled sites fully or partially reclaimed as new sites are drilled. Once drilling and stimulation activities are completed and the sites have been reclaimed, the long-term impact at the sites will consist of widely spaced and partially re-vegetated production sites and fully reclaimed plugged and abandoned well sites. However, for aquatic resources, there are areas of concern for cumulative impacts with regard to water use, ground disturbance, and contamination issues. The discussions below are examples of regional effects from these areas of concern.

Evaluation of cumulative impacts of multiple water withdrawals must consider the existing water usage, the non-continuous nature of withdrawals and the natural replenishment of water resources. Concerns over decreased streamflow from regional water withdrawals and the potential effect this has on aquatic habitat, water quality, and recreational use of rivers has prompted recent research in the East. In Massachusetts, cumulative withdrawal of ground water substantially decreased low flows in the Ipswich River (USGS 2001); while research in this and other rivers documented measurable alterations in fish communities following water withdrawal induced habitat changes (Armstrong et al. 2001; Freeman 2005; Vokoun and Kanno 2009). In addition to stream effects, the USGS reports that land subsidence due to the pumping of ground water occurs in nearly every State (USGS 1995).

Regional cumulative effects of water contamination and sedimentation to aquatic organisms have been documented for many species. The adverse modification and destruction of aquatic habitats, water pollution, and the introduction of non-indigenous species, have been the major causes of mussel declines and extinctions during this century (Stein et al. 2000). Of all the factors contributing to the jeopardized status of Southeastern native freshwater fishes, non-point source pollution (primarily siltation) and alteration of flow regimes (primarily impoundment) are the largest contributors to fish imperilment. Etnier (1997) points out that these two anthropogenic factors are responsible for 72% of imperilment problems.

Freshwater mussel and fish populations have been reduced and, in some cases, completely extirpated from lakes and streams by pollutants from municipal, industrial, and agricultural sources. Effluents impacting aquatic organisms include industrial discharges, fly ash and sulfuric acid spills, acid mine drainage, organic wastes, insecticides, and chlorinated sewage (USDI Fish and Wildlife Service 1990). In addition, sub-lethal bioaccumulation of toxins can reduce overall health and fitness of an individual or population. Fish advisory warnings are currently in place on five river reaches in Virginia (for mercury, PCBs, and kepone) (FORVA 2001).

Alternative Comparison

Common to all alternatives are 1) private mineral rights on NFS lands, and 2) existing federal oil and gas leases. The potential federal oil and gas activity on 100% federal mineral ownership will vary by alternative. See the Federal Oil and Gas Leasing Availability Decision by Alternative discussion in the EIS for more detail regarding federal and private ownership, current leases, and proposed stipulations. For alternative comparison in light of water resources and aquatic species, Table 3D-6 shows projected activity for both federal and private oil and gas leases.

Because the only drilling that would be done in Alternatives C and I is that under private ownership and existing federal leases, Alternatives C and I has the lowest potential for ground-disturbing activities, and least amount of water use. Those numbers are slightly higher in Alternatives E and G, because although they allow vertical wells, these alternatives exclude horizontal drilling, significantly decreasing the amount of water use and potential for contamination. Alternative H has the next highest numbers, followed by F, D and B. Lastly, Alternative A most closely corresponds to the RFD and has the highest potential for ground disturbance and uses the most amount of water.

Alternative H would allow no surface water or groundwater withdrawals from National Forest System lands unless an analysis showed that the overall impacts of the drilling could be reduced through the use of withdrawals from the Forest. Alternative H would also require closed loop systems for hydraulic fracturing and the use of a secondary containment system to reduce the risk of spills entering the stream system. It would also make public water supply watersheds (including the watershed upstream of the Dry River PWS) administratively unavailable for leasing. The result is that Alternative H would have the lowest potential for impacts on water and aquatic systems among the alternatives that allow horizontal drilling.

Under Alternative H, the application of forestwide standards and resource protection measures are designed to limit the extent and duration of adverse environmental effects. The allocation of lands to management prescriptions, the decisions on lands administratively available for leasing, and the decisions on leasing stipulations (like No Surface Occupancy) limit the exposure of the most sensitive resources to the risk of adverse environmental impacts. The record of declining violations in Pennsylvania is encouraging and many state and federal agencies are developing improved regulations to respond to past incidents. However, the record from drilling in other states indicates that there will be accidents, improper implementation of control measures and unintended actions that result in impacts to aquatic resources (see *Appendix I - Gas Drilling Concerns*).

In addition to accidents, the mountainous terrain results in the potential for increased erosion and sedimentation from soil disturbances associated with road and well pad construction, and associated facilities and pipelines. These effects can be long-term as they involve land use conversion from forest to non-forest with a loss of soil productivity and natural landform. There is also the potential for increased runoff on compacted soils which could cause changes to streamflow volumes and timing of flows. Some level of sediment from roads will reach streams and wetlands and could impact the physical characteristics and biological integrity of water resources.

Under all alternatives where horizontal drilling is allowed, some level of adverse effects to the above resources is likely unavoidable and it is important to note actual effects do not occur until project-level decisions are implemented. If we assume that newly developed regulations and control measures cut violations in half, we can still expect five to ten percent of wells to have problems. Of these from three to twenty-five percent of the wells could cause major impacts (see *Appendix I – Analysis of Concerns and Risks of Horizontal Drilling and Hydraulic Fracturing*). This would translate to about one to two wells. While this is a small amount, the previously identified extent of the sensitive aquatic resources could still result in impacts to miles of streams serving sensitive aquatic resources. In addition, it assumes a level of compliance with regulations and lack of accidents that has not yet been demonstrated. This level of impact generates concerns that require the continued search for improved control measures and greater oversight to reduce unintended actions during implementation.

Aquatic Viability Determinations for Oil and Gas Leasing

Within the Forest Plan Revision analysis, separate viability determinations were made for each watershed where a species occurs, because in many cases watersheds support separate populations, and because factors affecting viability can vary considerably from watershed to watershed. Viability outcomes from each species by watershed were determined by incorporating elements of species distribution, abundance, and sensitivities to environmental factors; watershed condition relative to the species' environmental sensitivities; and the national forest role in the watershed. To include the effects from oil and gas leasing, the amount of Marcellus shale by species and watershed was determined, as well as whether or not the species occurrence was on federally or privately owned mineral rights (see Table J1 Appendix J). Only those species found in watersheds with Marcellus shale were included. Viability outcomes by watershed that were determined in the EIS based on stressors were then evaluated in light of the additional stressor of horizontal drilling in Marcellus shale. Viability outcomes by species, by watershed with the potential for drilling in the Marcellus shale formation and Forest Plan Alternatives are found in Table J2, Appendix J. Viability outcomes are:

Outcome A. Species is well distributed and abundant within watershed. Forest Service may influence conditions in the watershed to keep it well distributed. Likelihood of maintaining viability is high.

Outcome B. Species is potentially at risk in the watershed; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome C. Species is potentially at risk within the watershed; however, the extent and location of NFS lands with respect to the species is NOT conducive to positively influence the sustainability of the species within this watershed. Therefore, species viability in the watershed may be at risk.

Outcome D. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk; however, the extent and location of NFS lands with respect to the species is conducive to positively influence the sustainability of the species within this watershed. Therefore, likelihood of maintaining viability is moderate.

Outcome E. The species is so rare within the watershed (population is at very low density and/or at only a few local sites) that stochastic events (accidents, weather events, etc.) may place persistence of the species within the watershed at risk. Forest Service ability to positively influence the species is limited. Therefore species viability in the watershed may be at risk.

A summary of the changes by alternative is below.

Table 3D-15. Viability Outcomes by Alternative based on Marcellus Shale Potential Development

Viability Outcome	Number of Species/Watershed Combinations with the Specified Outcome								
	EIS viability outcome	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
A (Low Risk)	7	2	2	6	2	6	2	6	2
B (Moderate Risk, FS May Positively Influence)	30	10	10	20	10	20	10	20	15
C (Potential High Risk, Little Opportunity for FS Influence)	43	68	68	54	68	54	68	54	63
D (Moderate Risk, FS May Positively Influence)	22	17	17	21	17	21	17	21	18
E (Potential Very High Risk, Little Opportunity for FS Influence)	13	18	18	14	18	14	18	14	17

Changes to aquatic species viability based on the additional stressor of horizontal drilling in Marcellus shale were similar in Alternatives C, E, G and I because none of the alternatives allow horizontal drilling. The species viability changed from low or moderate risk to potential high or very high risk in those watersheds where the species occurrence was on Marcellus shale in National Forest, but with privately owned mineral rights.

Changes to aquatic species viability were similar in Alternatives A, B, D, and F because all of those alternatives allow horizontal drilling in Marcellus shale to some extent. The species viability changed from low or moderate risk to potential high or very high risk in those watersheds where the species occurrence was on Marcellus shale in National Forest. The exception was in the North Fork South Branch Potomac River watershed (includes the Laurel Fork area), where although the area is underlain by Marcellus shale in Federal ownership, oil and gas leasing of the area will not be allowed in all alternatives.

Changes to aquatic species viability in Alternative H were in between those of the two other alternative groupings described above. This is because Alternative H allows horizontal drilling in Marcellus shale but has restricted it in more areas than Alternatives A, B, D, and F.

Vegetation

The Reasonably Foreseeable Development (RFD) for federal oil and gas on the George Washington National Forest is related primarily to the Marcellus shale formation. Potential areas of development contain a full range of ecological systems as well as a range of site productivity depending upon the specific location of projected activities. Table 3D-16 indicates the level of clearing during the first 10 years of plan implementation as well as the projected volume of timber that would be removed for each alternative.

Table 3D-16. Acres Cleared and Associated Timber Removal Volumes for the Federal Leases

Alternative	Acres Cleared	Volume (CCF, Hundred Cubic Feet)
A	1,436	29,000
B	833	17,000
C and I	0	0
D	833	17,000
E	168	3,000
F	446	9,000
G	173	3,000
H	380	8,000

Assumption of average volume per acre cleared equals 20 CCFs.

As Table 3D-16 displays, Alternatives A, B, and D oil and gas leasing could result in substantially more acres of vegetation during the first 10 years of plan implementation. Alternatives E through H would result in comparatively less acres of vegetation cleared. However, in all cases less than 1% of the forested acres on the GWNF would be impacted. Many if not most of these acres would likely be removed from timber production for the foreseeable future. Alternatives C and I would result in no clearing. All vegetation would be removed from the acres cleared for well sites, access roads, and associated pipelines. Some revegetation or restoration of disturbed areas after completion of gas exploration may eventually result in similar vegetation being established on portions of the cleared area.

Fair market value for timber volume indicated in 3D-16 will be obtained through timber settlement sale or commercial timber sale regulations as individual site development occurs. Every effort will be made to make marketable timber available to local markets.

Special Biological Areas, Caves and Rare Communities

The Reasonably Foreseeable Development assumes that oil and gas activities will occur for the exploration and development of the Marcellus Shale, primarily on the Lee, North River, Warm Springs, and James River Ranger Districts. A number of rare communities, caves, and Special Biological Areas occur on the Forest and they act as a "coarse filter" for the protection of biological diversity. According to SAMAB (1996) about 66% of TES species are associated with rare communities, and the percentage increases even further when riparian areas are included. By protecting rare communities, including caves, a very large number of TES plant and animal species also receive protection. Added to this are Special Biological Areas where single occurrences or assemblages of TES species are recognized and protected.

The possible effects of oil and gas development on rare communities, caves, and Special Biological Areas include removal of tree species, ground disturbance, changes in hydrology, changes in soil temperature, and possible invasion by non-native species. Even though there may be activities associated with oil and gas development, the Plan Standards provide protection for threatened, endangered, and sensitive species that occur within rare communities, caves, and Special Biological Areas. The areas may receive some disturbance, but project and site-specific analysis will include mitigation to prevent damage to the integrity of these areas and the species that depend on them.

Forest Plan direction for rare communities, caves, and Special Biological Areas is to protect the natural resource values associated with them. They are generally not actively managed, except where necessary for their restoration and maintenance.

In Alternative H Special Biological Areas, Key Natural Heritage Community Areas, and the Shenandoah Crest are all only available under No Surface Occupancy. This will provide further protection for any rare species associated with these areas.

Management Indicator Species

Concerns regarding overall biodiversity of the areas proposed for federal oil and gas development are best addressed through the use of Management Indicator Species (MIS) as designated by the Forest Plan (Table 3B2-8). Wildlife resources on the Forest are located in Virginia and West Virginia and are managed in cooperation with the Virginia Department of Game and Inland Fisheries (VDGIF) and the West Virginia Division of Natural Resources (WVDNR). State wildlife agencies set policy for hunting and fishing regulations and associated law enforcement programs. The Forest Service manages the habitat conditions for wildlife. The following discussion focuses on the habitat conditions that support wildlife populations in the area.

Under the National Forest Management Act (NFMA) the Forest Service is charged with providing for a diversity of plant and animal communities consistent with overall multiple use objectives. Management Indicator Species (MIS) are a planning tool used to accomplish this requirement (36 CFR 219.19). They are selected during forest planning "because their population changes are believed to indicate the effects of management activities" (36 CFR 219.19(a)(1)) on important elements of plant and animal diversity.

The Reasonably Foreseeable Development (RFD) for federal oil and gas (particularly in the Marcellus shale) on the George Washington National Forest is concentrated on the Lee, North River, Warm Springs, and James River Ranger Districts.

Cow Knob Salamander. This salamander is a species with a restricted range. It is endemic to the higher elevations of Shenandoah Mountain along the VA/WV border. It is a terrestrial salamander that occurs primarily above 2,500 feet in elevation and mainly occurs in rocky talus areas on north to northeast aspects. It forages openly on cool to warm, dark, humid/rainy nights consuming small insects and other invertebrates. The Cow Knob salamander is an MIS because it is a Sensitive species and a narrow endemic that occurs almost entirely on the George Washington National Forest (North River Ranger District). The range of the Cow Knob salamander overlaps with the location of Marcellus shale on the Forest. Under an agreement with the U.S. Fish and Wildlife Service (1994) no road construction is permitted on the Forest within the Cow Knob conservation area. This would greatly inhibit gas well development. The agreement also states, that while the

conservation area is available for oil and gas leasing, controlled surface use stipulations will be used to protect the salamander's habitat and populations. These controlled surface use stipulations are subject to approval by the Cow Knob salamander Conservation Team. In Alternative H the Shenandoah Crest and the area south of Highway 250 on Shenandoah Mountain greater than 3,000 feet in elevation are only available with No Surface Occupancy.

Pileated Woodpecker. The Pileated Woodpecker generally prefers mature deciduous forests ranging from bottomlands to uplands. Key habitat requirements include older mature forests with dead trees (snags) for nesting. Pileated woodpeckers will also nest in large dead limbs on live trees. Nests are large cavities they construct usually over 30 feet above the ground. They feed on ants, insects, and insect larvae (mainly carpenter ants and wood-boring beetles) found by probing under the bark of standing trees and in stumps or fallen logs. Some fruits and berries are taken in fall and winter (Hamel 1992). These woodpeckers are year-round residents. The pileated woodpecker is an MIS for snag dependent wildlife.

Ovenbird. Preferring mature, dry, deciduous hardwoods with a closed canopy, the ovenbird is an area sensitive MIS requiring relatively large undisturbed tracts. As ground nesters, they are especially vulnerable to predators. Breeding habitat is deciduous or mixed forest (rarely pure pine woods) with moderate understory, preferably in uplands. Since the ovenbird is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas, not the Forest.

Chestnut-sided Warbler. The habitat of this common warbler is typically second-growth hardwoods and overgrown fields in the Appalachian Mountains over 3,500 feet. On the Forest it's therefore found in the Blue Ridge, Ridge and Valley, and Cumberland mountains. It's most numerous in abandoned fields with scattered saplings, along woodland edges, and in open park-like deciduous woods. It nests 1 to 4 feet above the ground in saplings and shrubs and feeds on insects gleaned from leaves and twigs in deciduous vegetation (Hamel 1992). The chestnut-sided warbler is an MIS for high elevation early-successional habitats because of its strong association with these habitats, and because its populations should be responsive to forest management efforts that create and sustain such habitats. Also, the chestnut-sided warbler is effectively monitored using established breeding bird survey protocols. Since the chestnut-sided warbler is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas, not the Forest.

Acadian Flycatcher. This common flycatcher is found mainly in moist deciduous forests with a moderate understory near streams. Nests are found on horizontal or down-hanging branches of deciduous trees, usually over a stream. This arboreal hawking insectivore generally sits on a branch 10 to 40 feet high near a stream where it will sally after flying insects (Hamel 1992). The Acadian flycatcher is deemed an appropriate species to indicate management-induced changes to mature riparian forests. It is highly associated with mature deciduous forests along streams and bottomland hardwoods throughout the Forest. This species is selected to help indicate the effects of management activities on mature riparian habitats. Since the Acadian flycatcher is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas, not the Forest.

Eastern Towhee. Also called the Rufous-sided towhee, this widespread bird is found most commonly in upland brushy habitats, woodland margins, thickets, cut-over woods, and overgrown fields. Key habitat requirements are shrubs, saplings, and understory trees where a thicket is present. Nests are most often located in thickets and brushy places on the ground or in shrubs and saplings up to 5 feet off the ground. Towhees forage on the ground and in low shrubs where they scratch in leaf litter to expose insects, seeds, and fruits that they glean (Hamel 1992). Towhees are year-round residents although individuals will migrate short distances. The Eastern towhee was selected as an MIS to indicate the effects of management activities on early seral habitats.

Black Bear. The black bear is an opportunistic species that can thrive in a wide variety of habitats. The black bear's most important habitat need is considered to be freedom from constant human disturbance. Remote habitat free from the regular presence of humans is an important component of bear habitat quality. Access management does not refer to the prohibition of building or upgrading existing roads, but rather to their subsequent management after construction such as whether they're open or closed and the timing of closure. Roads in and of themselves are not detrimental; it's the use of these roads by the public that affects black

bear. At least five percent of the area should be in an age class of older trees and these should be well dispersed over the area. Mature forests with large diameter trees are needed to provide hard mast and hollow den trees.

Eastern Wild Turkey. Wild turkeys prefer mature forests (mid- to late successional) with open understories, temporary and permanent clearings well dispersed, and freedom from disturbance during nesting and brood rearing seasons. The key components of wild turkey habitat in oak-hickory forests are brood habitat, nesting and fall/winter habitat, and freedom from disturbance. Brood habitat is the most limiting factor to eastern turkey population in the central Appalachians (Pack, personnel communication). Hens with broods use a wide variety of habitats. These include pastures with hay fields, utility rights-of-way, wildlife clearings, burned areas, and natural glades or savannas; however, the structure of vegetation is as important as vegetation types (Healy 1981). In mature forests, ideal brood habitat includes at least 5% of the area in well-dispersed, permanent grass/herbaceous openings. Ground cover should consist of patchy vegetation that does not impede poult movements, yet provides good horizontal cover from predators, and produces abundant insects for food. Partially canopied (<60%) savannahs that are open and park-like with moderate herbaceous/shrubby understory with little midstory vegetation provide optimal brood habitat. Nesting and fall/winter habitat may include uncut hay fields, areas harvested for timber, and burned forests. Nesting habitat should be near brood habitat. Preferred and most successful nest sites seem to be on the edge of extensive stands of brush and herbaceous vegetation. Hard mast (usually acorns) is the most important fall food of the eastern turkey in the central Appalachians. Because of the variation in mast production between oak groups, a variety of oak species best provides sustained mast production. Ideal habitat includes at least 60% of the area in mast bearing age (50 years+). Human disturbance to hens and broods during the nesting and brood rearing season should be minimized. No more than one mile of open road per 1,000 acres will minimize this disturbance.

White-Tailed Deer. White-tailed deer use a variety of habitat types. White-tailed deer prefer early successional forest areas, woodland edge, and a mosaic of various forest age classes. A mixture of habitat types and resulting edge insures an abundant food source is available throughout the year. White-tailed deer heavily use hard mast in the fall (usually acorns) to accumulate sustaining fat reserves for the winter. During the winter woody browse makes up the majority of a deer's diet in the central Appalachians. In the spring and summer they consume young growing herbaceous plants, fruits, and woody shoots and leaves. Early successional habitat, generally no larger than 25 acres in size, well dispersed with approximately 10% of the area in the 0-10 age class provides forage and escape cover throughout the year. Well-dispersed forest openings 1/2 to 1 acre in size occupying up to 5% of the area and shrub-grass habitats provide necessary spring/summer foods. In extensive forested areas a minimum of 60% of the area maintained in mast bearing age (40 years +) provides suitable fall hard and soft mast for white-tailed deer.

Hooded Warbler. Habitat of this common warbler is moist deciduous and mixed forests with a dense understory, typically found in rich woods, ravines, and bottomlands. Key habitat requirements are forests (usually deciduous) with a thick, rich understory layer. The hooded warbler is rarely associated with moist deciduous forests above 4,000 feet (Hamel 1992). Nests are built 2 to 5 feet above the ground in shrubs and saplings where they are poorly concealed. These warblers forage primarily in shrubs within 15 feet of the ground by gleaning and hawking insect prey. The hooded warbler is an MIS for mid- to late-successional oak and oak-pine forests. Since the hooded warbler is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas south of the U.S. and not on the Forest.

Scarlet Tanager. This common woodland bird is typically found in upland mature deciduous (usually oak) forests for which it was selected as an MIS. It's most common in lower and middle elevations in the mountains up to 4,000 feet and is rarely found over 5,000 feet. The key habitat feature is mature deciduous forests. Nests are located 20 to 50 feet above the ground in a hardwood tree. The scarlet tanager feeds on insects that it gleans from twigs and leaves (Hamel 1992). In the fall it often will feed on berries. Since the scarlet tanager is a neotropical migrant, arriving in spring and departing in the fall, declines in populations may be caused by events happening on the wintering areas south of the U.S. and not on the Forest.

Pine Warbler. The pine warbler is closely associated with middle-aged to mature pine and pine-oak forests, generally occurring only where some pine component is present. While not among the common warblers, it is

considered the most appropriate MIS for the yellow pine habitat component. Nests are built in pines and foraging for insects occurs in the crowns of pines where they glean insects from needles and twigs (Hamel 1992). Since the pine warbler is a neotropical migrant, arriving in spring and departing the Forest in the fall, declines in populations may be caused by events happening on the wintering areas south of the U.S. and not on the Forest.

Wild Brook Trout. These trout are cold-water species that require water temperature less than 69 degrees Fahrenheit, dissolved oxygen values greater than 7.0 parts per million, and sedimentation rates that are in equilibrium with the watershed. To be considered "wild" they must be a reproducing population that is not dependent on stocking. Positive activities within watersheds that support wild trout are those that stabilize or improve the physical and biological conditions of the stream. For a complete discussion of effects on wild trout as an MIS in relation to this project see "*Aquatic Viability Determinations for Oil and Gas Leasing.*"

Beaver. Beavers were selected as an MIS because they are a keystone species that create wetland habitat with many physical and biological benefits. Beavers alter ecosystem hydrology, biogeochemistry, vegetation, and productivity with consequent positive effects on the plant, vertebrate, and invertebrate populations that occupy beaver-modified landscapes. Their impoundments trap fine textured sediments that act as water storage reservoirs, resulting in slow, sustained discharge that maintains streamflows during dry periods; afford protection from flooding of downstream areas; and produce a raised water table that enhances riparian zones. Additionally, beaver habitat modifications can reduce pollution and improve water quality in aquatic ecosystems, by trapping sediment and nutrients; reducing downstream turbidity; and purifying water from acidification and other non-point source pollutants. The capability of beavers to store water, trap sediment, reduce erosion, and enhance riparian vegetation can be used as a management tool to restore degraded aquatic and riparian ecosystems. Beavers are a habitat-modifying species and play a pivotal role in influencing community structure in many riparian and wetland systems. Restoring beaver populations to their maximum viability on public lands is desirable because of the beaver's capability to restore and maintain healthy riparian ecosystems. Key conservation elements for the beaver on National Forest System lands are, therefore, protection and enhancement of aquatic and riparian habitats by management of water resources and riparian vegetation, beaver population enhancement by natural recolonization and transplants where necessary, and proactive management of beaver damage issues.

The physical effects of oil and gas leasing upon wildlife include elimination of individual animals and their associated habitat by construction or reconstruction of access roads, clearing and leveling of drill pad sites, and construction of pipelines and off-site facilities, and reduction of availability and quality of water and wetland habitat (see aquatic viability determinations for oil and gas leasing). There is no anticipated gas well development in the next two decades on the Pedlar Ranger District. The potential impacts from new gas well development on the Lee, North River, Warm Springs, and James River Ranger Districts would vary by alternative.

Forest fragmentation can affect wildlife by encouraging species that use early successional and forest edge habitats, such as the MIS eastern towhee and wild turkey, and discouraging animals that use interior forest habitats, such as the ovenbird and hooded warbler. Under all alternatives, road, pipeline, facility, and drill pad construction would reduce existing mature forest habitat and increase the amount of edge in the project area. However, these hard mast/mature forest/old age forest habitat conditions will remain well connected over the 15-year period and forested travel corridors free from constant disturbance are maintained by road access closure. Forest fragmentation would be minimal given the narrow clearing widths for roads and pipelines and the small acreage disturbed when compared to the extensive surrounding unfragmented forests. Given the Lee, North River, Warm Springs, and James River Ranger Districts are in a generally forested landscape, the expected negative impacts of edge are not considered significant.

Early seral habitat would be increased in all alternatives where roads and/or well pads are not allowed to redevelop into forest conditions. The increase in grass/forbs under all alternatives would provide food source for such MIS as whitetail deer, wild turkey, and indirectly for such species as the eastern towhee. While hard mast is reduced under all alternatives due to reduction of forested acres, hard mast production capability is still retained on adjacent acreage. It is likely that soft mast production (fruits and berries) will increase under all alternatives with plants such as blackberry, raspberry, and pokeweed occurring where land is cleared.

Under all alternatives, road use during active drilling and post-drilling and production phases would include heavy truck traffic and during active drilling, round the clock truck use bringing water onto the site and taking used fluids away from the drilling pads. Noise impacts around the drilling sites and truck use of roads leading to drilling pads could impact wildlife, causing movement away from the drilling areas. While vegetation around roads and drilling pads may enhance habitat for some species of public interest such as white-tailed deer, black bear and wild turkey, hunting opportunities in these areas could be limited, due to the larger volume of traffic and noise during active drilling and production phases.

Numbers of snags will be reduced in all alternatives due to the number of acres of forest that will be cleared. Snag development generally takes 80 to 100+ years; therefore, even if cleared land is allowed to return to forest, it will take many decades for snags to develop once trees achieve a mature size and then die. However it is likely this loss of snags will be offset over time by increased tree mortality resulting from insect infestations such as gypsy moth and pine bark beetles.

In those Alternatives where horizontal drilling is allowed (A, B, D, F, and H), development activities would be controlled in riparian areas through lease stipulations or conditions of approval on plans of operation. However, impacts from water withdrawal and/or non-point source pollution on wetland and riparian habitat could have impacts on riparian MIS such as Acadian flycatcher, pileated woodpecker, beaver, and brook trout (see "*Aquatic Viability Determinations for Oil and Gas Leasing*").

A summary of expected effects to MIS are shown in Table 3D-17 below.

Table 3D-17. Expected Effects to Management Indicator Species by Alternative

Common Name	Management Effects Indicated	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Cow Knob Salamander	TES species dependent on mature, moist hardwood forest	=/=	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Pileated Woodpecker	Snag-dependent wildlife species	=/-	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Ovenbird	Mature forest interior species	=/-	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Chestnut-sided Warbler	High-elevation early successional species	=/=	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Acadian Flycatcher	Mature riparian forest dependent species	=/=	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Hooded Warbler	Mid- and late successional deciduous forest species, inc. mixed mesophytic, oak & oak-pine forests	=/-	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Eastern Towhee	Early seral habitat	=/+	=/+	=/+	=/+	=/+	=/+	=/+	=/+
Scarlet Tanager	Upland oak forest species	=/-	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Pine Warbler	Mid- and late successional pine and pine-oak forests	=/-	=/-	=/-	=/-	=/-	=/-	=/-	=/-
Deer	Meeting hunting demand for this species	=/+	=/+	=/+	=/+	=/+	=/+	=/+	=/+
Beaver	Keystone wetland species	=/-	=/-	=/=	=/-	=/=	=/-	=/=	=/-
Eastern Wild Turkey	Meeting hunting demand for this species	=/+	=/+	=/+	=/+	=/+	=/+	=/+	=/+
Black Bear	Meeting hunting demand for this species	=/=	=/=	=/=	=/=	=/=	=/=	=/=	=/=
Wild Brook Trout	Meeting angling demand for this species	=/--	=/--	=/=	=/--	=/=	=/--	=/=	=/-

Population trend expressed as expected change from current levels following implementation of proposed action: "++" relatively large increase, "+" increase, "=" little to no change, "-"decrease, "- -" relatively large decrease.

Threatened, Endangered and Sensitive (TES) Species

The majority of the Reasonably Foreseeable Development for oil and gas will occur on the Lee, North River, Warm Springs, and James River Ranger Districts which provide habitat for 7 federally threatened and endangered terrestrial species, which include 3 plants, 3 mammals and one mussel. Two federally listed species, Virginia sneezeweed and swamp pink occur only on the Pedlar Ranger District where there is no Marcellus Shale and, therefore, are not considered further. There are no known occurrences of the Madison Cave isopod on the GNWF, but about 700 acres of potential habitat have been modeled on the Forest. There are 70 terrestrial species designated by the Regional Forester as sensitive on the Lee, North River, Warm Springs, and James River Ranger Districts. Sensitive species include species occurring on the Forest with range-wide viability concerns, but which are not included on lists of endangered, threatened, proposed, or candidate species. Sensitive species receive special management emphasis in order to ensure their viability and to preclude trends toward federal listing or endangerment. Forest terrestrial threatened, endangered, and sensitive species that might be affected by the oil and gas leases occur in two ecological sections: the Northern Ridge and Valley, and the Allegheny Front. Each of these sections contains distinct geologies and landforms, which give rise to a variety of unique habitats such as boreal forests, caves, wetlands, shale barrens, fire-adapted communities, glades, sinkholes, and springs. These unique habitats, in turn, support assemblages of rare plant and animal species. In addition to the habitat diversity found in the ecological sections, the Forest encompasses a wide range of latitude. Many plant and animal species more typically associated with northern or southern biomes reach the limit of their range on the Forest. For the oil and gas leasing analysis, species that could potentially be affected are shown below:

Table 3D-18. TES Species Potentially Affected by Oil and Gas Leasing on the GWNF

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
VERTEBRATES							
Fish							
Notropis semperasper	Roughhead shiner	Upper James R watershed above Buchanan	Aquatic-rivers	S	G2G3	S2S3	-
Noturus gilberti	Orangefin madtom	S Fk Roanoke R watershed, Roanoke R above Salem, Craig Ck, Johns Ck, Cowpasture R	Aquatic-streams	S	G2	S2	-
Amphibian							
Plethodon punctatus	Cow Knob salamander	Shenandoah Mtn, VA & WV	Mixed oak, late successional with loose rocks and logs, >2500'	S	G3	S2	S1
Birds							
Falco peregrinus	Peregrine Falcon	Hack sites late 80s & early 90s No nests, current migrant.	Nests on ledges or cliffs, buildings, bridges, quarry walls. Non-breeding sites, farmland, open country, lakeshores, broad river valleys, airports	S	G4	S1B/S2N	S1B/S2N
Haliaeetus leucocephalus	Bald Eagle	Potomac R, James R watershed	Feeds and nests on or near large lakes and rivers	S	G5	S2S3B/S3N	S2B/S3N
Lanius ludovicianus migrans	Migrant Loggerhead Shrike	Ridge & Valley (Shenandoah Valley)	Open grasslands with trees and shrubs, fencerows	S	G4	S2B/S3N	S1B/S2N
Thryomanes bewickii altus	Appalachian Bewick's wren	Historical records in Botetourt, Giles, Highland, Washington Cos	Thickets, old fields, fencerows, old home sites	S	G5T2Q	S1B/SZN	S1B/S1N

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Mammals							
Corynorhinus townsendii virginianus	Virginia big-eared bat	Summer: VA - Highland Co. (1 cave), WV - Pendleton Co. (4 caves); Winter: Highland, Rockingham, Pendleton Co. (6 caves), largest WV population in Pendleton Co. Small #'s of bats (usually <10) in a few other widely scattered caves during summer months. Bath & Pulaski County records are historic, no occupied caves currently known.	Resides in caves winter and summer. Short distance migrant (<40 miles) between winter and summer caves. Forages primarily on moths and foraging habitat is common (fields, forests, meadows, etc.). Forages within 6 miles of summer caves. USFWS Critical Habitat is 5 caves in WV (4 Pendleton Co. & 1 Tucker Co.). Closest Critical Habitat cave to GWJNF is ~3 miles in Pendleton Co., WV.	E	G4T2	S1	S2
Glaucomys sabrinus fuscus	Virginia northern flying squirrel	Laurel Fork area, Highland Co	Spruce-fir forests and adjacent northern hardwoods	E	G5T2	S1	S2
Microtus chrotorrhinus carolinensis	Southern rock vole	Alleghany Mtn, Bath Co	Cool, moist, mossy talus under oaks/northern hardwoods	S	G4T3	S1	S2
Myotis leibii	Eastern small-footed bat	Ridge & Valley	Hibernates in caves during winter, roosts in crevices of large rock outcrops, cliffs, & under large rocks in talus & boulder-fields during summer, forages widely in all forested and open habitat types over both ridges and valleys.	S	G3	S1	S1
Myotis sodalis	Indiana bat	Blue Ridge, Ridge & Valley, Cumberland Mtns	Caves winter, upland hardwoods summer, forages widely along riparian areas and open woodlands	E	G2	S1	S1
Sorex palustris punctulatus	Southern water shrew	Alleghany Mtn, Bath Co; & Laurel Fork, Highland Co	Riparian areas w/in spruce-fir forests and northern hardwoods	S	G5T3	S1S2	S1
INVERTEBRATES							
Snail (Mollusk, Class Gastropoda)							
Glyphyalinia raderi	Maryland glyph	Alleghany, Montgomery Cos	Calciphile, edge of seeps within leaf litter	S	G2	S1S2	S2
Helicodiscus diadema	Shaggy coil	Alleghany Co	Calciphile, limestone rubble and talus	S	G1	S1	-
Helicodiscus lirellus	Rubble coil	Rockbridge Co	Calciphile, limestone rubble and talus	S	G1	S1	-
Helicodiscus triodus	Talus coil	Alleghany, Botetourt, Rockbridge Cos	Calciphile, limestone rubble on wooded hillsides and caves	S	G2	S1S2	SH
Clam and Mussel (Mollusk, Class Bivalvia)							
Alasmidonta varicosa	Brook floater	Potomac drainage	Aquatic-rivers	S	G3	S1	S1
Elliptio lanceolata	Yellow lance	Roanoke R, James R	Aquatic-rivers	S	G2G3	S2S3	-
Lasmigona subviridis	Green floater	Widely distributed in N & S Fk Shenandoah R, Pedlar R, James R	Aquatic-rivers	S	G3	S2	S2
Pleurobema collina	James spinymussel	Potts Ck, Craig Ck, Johns Ck, Patterson Run, Pedlar R, Cowpasture R, Mill Ck (Deerfield)	Aquatic-rivers	E	G1	S1	S1

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Amphipod (Crustacean, Order Amphipoda)							
Stygobromus gracilipes	Shenandoah Valley cave amphipod	Frederick, Rockingham, Shenandoah, Warren Cos	Caves	S	G3G4	S2S3	S1
Stygobromus hoffmani	Alleghany County cave amphipod	Low Moor cave, Alleghany Co	Caves	S	G1	S1	-
Stygobromus mundus	Bath County cave amphipod	Alleghany, Bath Cos	Caves	S	G2G3	S1S2	-
Isopod (Crustacean, Order Isopoda)							
Miktoniscus racovitzai	Racovitza's terrestrial cave isopod	Alleghany, Botetourt, Page, Rockbridge, Shenandoah Cos	Caves	S	G3G4	S2	-
Antrolana lira	Madison Cave Isopod	Augusta, Rockingham, Warren and Clarke Cos	Caves	T	G2G4	S2	S1
Millipede (Class Diplopoda)							
Nannaria shenandoah	Shenandoah Mountain Xystodesmid millipede	One site: along Long Run Road, Rockingham Co	Leaf litter, mixed oak forest	S	G1	S1	-
Pseudotremia alecto	a millipede	Griffith Knob, Alleghany Co; near Mountain Grove Saltpetre cave, Bath Co	Leaf litter, deciduous forests	S	G1	S1	-
Centipede (Insect, Order Chilopoda)							
Nampabius turbator	a cave centipede	One known site: Low Moor cave, Alleghany Co	Caves	S	G1G2	S1	-
Springtail (Insect, Order Collembola)							
Arrhopalites carolynae	A cave springtail	Augusta, Highland, Bath, Lee, Wise Cos	Caves	S	G2G4	S1	-
Arrhopalites sacer	A cave springtail	Bath Co	Caves	S	G1G2	S1	-
Dragonfly and Damselfly (Insect, Order Odonata)							
Gomphus viridifrons	Green-faced clubtail	New R, Craig Ck, Pound R, Locust Spring	Aquatic-rivers	S	G3	S2	S2
Beetle (Insect, Order Cloeoptera)							
Cicindela ancocisconensis	Appalachian tiger beetle	Alleghany, Bath, Highland, Lee, Rockbridge, Washington, Wise Cos	Riparian – sandy/silty edges of streams and rivers	S	G3	S2	S3
Cicindela patruela	Northern barrens tiger beetle	Blue Ridge, Ridge & Valley	Eroded slopes of exposed sandstone and conglomerate	S	G3	S2	S2S3
Hydraena maureenae	Maureen's shale stream beetle	Alleghany, Bath, Botetourt, Bland, Craig, Cos	Interstitial water in riparian-shale substrate along stream edge	S	G1G3	S1S3	-
Butterfly and Moth (Insect, Order Lepidoptera)							
Callophrys irus	Frosted elfin	Frederick, Montgomery, Page, Roanoke Cos	Dry, open woods, clearings, and road/powerline ROWs w/ abundant wild indigo (*Baptisia tinctoria*)	S	G3	S2?	S1

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Erynnis persius persius	Persius duskywing	Blue Ridge, Ridge & Valley	Bogs, wet meadows, open seepages in boreal forests	S	G5T1T3	S1	-
Pyrgus centaureae wyandot	Appalachian grizzled skipper	Ridge & Valley	Shale barrens, open shaley oak woodlands	S	G5T1T2	S1S2	S1
Speyeria diana	Diana fritillary	Blue Ridge, Ridge & Valley	Grasslands-shrublands, near streams with thistles and milkweeds, larval host plant, violets	S	G3G4	S3	S2S3
Speyeria idalia idalia	Regal fritillary	Blue Ridge, Ridge & Valley	Riparian, grasslands-shrublands	S	G3T1Q	S1	S1
Catocala herodias gerhardi	Herodias underwing	Bald Knob, Bath; Poverty Hollow, Montgomery Co; Sand Mtn, Wythe Co (non FS property)	Pitch pine/bear oak scrub woodlands, >3000'	S	G3T3	S2S3	SU
Erythroecia hebardi	Hebard's noctuid moth	Bath Co	Rich, mesic hardwood forest. Larvae host plant is Canada horse-balm (*Collinsonia canadensis*).	S	GU	SH	-
Euchlaena milnei	Milne's euchlaena moth	Edinburg Gap, Shenandoah Co	Moist, forested slopes of mixed pine hardwoods. Acidic oak woods.	S	G2G4	S2	S2
NON-VASCULAR PLANTS							
Lichen							
Hydrothyria venosa	Waterfan	Amherst, Alleghany, Bedford, Botetourt, Giles, Madison, Nelson, Rockbridge, Shenandoah Cos	Aquatic – in streams/springs/cascades	S	G3G5	S1	-
Liverwort							
Nardia lescurii	a liverwort	Blue Ridge, Ridge & Valley	Riparian – on peaty soil over rocks, usually in shade and associated w/ water, <3000'	S	G3?	SU	-
VASCULAR PLANTS							
Aconitum reclinatum	Trailing white monkshood	Blue Ridge, Ridge & Valley	Rich cove sites, streambanks, seepages all with high pH	S	G3	S3	S3
Allium oxyphilum	Nodding onion	Monroe, Summers, Mercer, Greenbrier Cos, WV	Shale barrens, sandstone glades	S	G2Q	-	S2
Arabis patens	Spreading rockcress	Frederick, Lee, Page, Shenandoah, Warren Cos	Shaded, calcareous cliffs, bluffs, and talus slopes	S	G3	S2	S2
Arabis serotina	Shale barren rockcress	Ridge & Valley N of New R watershed	Shale barrens and adjacent open oak woods	E	G2	S2	S2
Berberis canadensis	American barberry	Blue Ridge, Ridge & Valley	Calcareous open woods, bluffs, cliffs, and along fencerows	S	G3	S3S4	S1
Buckleya distichophylla	Piratebush	Blue Ridge S of Roanoke R, Ridge & Valley S of James R	Open oak and hemlock woods	S	G2	S2	-
Carex polymorpha	Variable sedge	Blue Ridge, Ridge & Valley, N of James R	Open acid soil, oak-heath woodlands, responds to fire	S	G3	S2	S1
Carex schweinitzii	Schweinitz's sedge	Bath, Montgomery, Pulaski, Washington Cos	Bogs, limestone fens, marl marshes	S	G3G4	S1	-
Clematis coactilis	Virginia white-haired leatherflower	Ridge & Valley, Rockbridge Co, S to Wythe Co	Shale barrens, rocky calcareous woodlands	S	G3	S3	-

Species Name	Common Name	Range on or near GWJNFs	Habitat - Detail	TES	G Rank	VA SRank	WV SRank
Corallorhiza bentleyi	Bentley's coralroot	Alleghany, Bath, Giles Cos VA; Monroe, Pocahontas Cos WV	Dry, acid woods, along roadsides, well-shaded trails	S	G1G2	S1	S1
Delphinium exaltatum	Tall larkspur	Blue Ridge, Ridge & Valley	Dry calcareous soil in open grassy glades or thin woodlands	S	G3	S3	S2
Echinacea laevigata	Smooth coneflower	Alleghany, Montgomery Cos	Open woodlands and glades over limestone or dolomite	E	G2G3	S2	-
Euphorbia purpurea	Glade spurge	Blue Ridge, Ridge & Valley	Rich, swampy woods, seeps and thickets	S	G3	S2	S2
Heuchera alba	White alumroot	Shenandoah Mtn	High elevation rocky woods and bluffs	S	G2Q	S2?	S2
Hypericum mitchellianum	Blue Ridge St. John's-wort	Blue Ridge, Ridge & Valley	Grassy balds, forest seepages, moderate to high elevations	S	G3	S3	S1
Iliamna remota	Kankakee globe-mallow	Alleghany, Botetourt, Rockbridge, Bedford Cos	Open, disturbed riverbanks and roadsides	S	G1Q	S1	-
Juglans cinerea	Butternut	Blue Ridge, Ridge & Valley	Well-drained bottomland and floodplain, rich mesophytic forests mostly along toeslopes	S	G4	S3?	S3
Liatris helleri	Turgid Gayfeather	Blue Ridge, Ridge & Valley	Shale barrens, mountain hillside openings	S	G3	S3	S2
Lycopodiella margueritae	Marguerite's clubmoss	Bath Co	Seasonally moist soils, wet acidic ditches, borrow pits	S	G2	NA	-
Monotropsis odorata	Sweet pinesap	Blue Ridge, Ridge & Valley	Dry oak-pine-heath woodlands, soil usually sandy	S	G3	S3	S1
Paxistima canbyi	Canby's mountain lover	Ridge & Valley	Calcareous cliffs and bluffs, usually undercut by stream	S	G2	S2	S2
Phlox buckleyi	Sword-leaf phlox	Blue Ridge, Ridge & Valley	Open, often dry oak woodlands and rocky slopes, usually over shale in humus rich soils, often along roadsides	S	G2	S2	S2
Poa paludigena	Bog bluegrass	Blue Ridge, Ridge & Valley	Shrub swamps and seeps, usually under shade	S	G3	S2	S1
Potamogeton hillii	Hill's pondweed	Bath Co	Clear, cold calcareous ponds	S	G3	S1	-
Potamogeton tennesseensis	Tennessee pondweed	Ridge & Valley	Ponds, back water of streams and rivers	S	G2	S1	S2
Pycnanthemum torrei	Torrey's mountain-mint	Bland, Bath, Giles, Rockbridge, Wythe Cos	Open, dry rocky woods, roadsides, and thickets near streams, heavy clay soil over calcareous rock	S	G2	S2?	S1
Scirpus ancistrochaetus	Northeastern bulrush	Ridge & Valley	Mountain ponds, sinkhole ponds in Shenandoah Valley.	E	G3	S2	S1
Scutellaria saxatilis	Rock skullcap	Blue Ridge, Ridge & Valley	Rich, dry to mesic ridgetop woods, 32 counties in VA, likely G4/S4	S	G3	S3	S2
Sida hermaphrodita	Virginia mallow	Ridge & Valley, James R watersheds	Riverbank glades with loose rock or sandy soil	S	G3	S1	S3
Trillium pusillum var. moniticulum	Mountain least trillium	Great North Mtn & Shenandoah Mtn, VA & WV	Open oak woodlands in well-drained soil and margins of thickets	S	G3T2	S2	S1
Vitis rupestris	Sand grape	Ridge & Valley	Scoured banks of rivers and streams over calcareous bedrock	S	G3	S1?	S2

P=potentially affect by oil and gas leasing, E=endangered, T=threatened, S=sensitive

Federally Listed Species

Following is a brief description of each of the federally listed plant and animal species currently known to exist on the Lee, North River, Warm Springs, and James River Ranger Districts along with current management strategies for recovery.

Table 3D-19. Federally Threatened and Endangered Species for the GWNF

Taxa	Species	Status
Mammal	Indiana Bat (*Myotis sodalis*)	Endangered
Mammal	Virginia Big-Eared Bat *(Corynorhinus townsendii virginianus)*	Endangered
Mammal	Virginia Northern Flying Squirrel *(Glaucomys sabrinus fuscus)*	Endangered
Mussel	James Spinymussel (*Pleurobema collina*)	Endangered
Arthropod	Madison Cave Isopod *(Antrolana lira)*	Threatened
Vascular Plant	Shale Barren Rock Cress (*Arabis serotina*)	Endangered
Vascular Plant	Smooth Cone Flower (*Echinacea laevigata*)	Endangered
Vascular Plant	Virginia Sneezeweed (*Helenium virginicum*)	Threatened
Vascular Plant	Swamp Pink (*Helonius bullata*)	Threatened
Vascular Plant	Northeastern Bulrush (*Scirpus ancistrochaetus*)	Endangered

All of the known locations of the five listed plants and northern flying squirrel are in Special Biological Areas. The Laurel Fork Area, which has all currently known populations of northern flying squirrel, is unavailable for leasing under all alternatives. Virginia sneezeweed, swamp pink and northeastern bulrush are also confined to riparian areas. Riparian areas and Special Biological Areas have standards that should protect them from direct activities of gas drilling. In addition, Alternative H makes all Special Biological Areas as available only under No Surface Occupancy.

Indiana bat (*Myotis sodalis*). The distribution of Indiana bats is generally associated with limestone caves in the eastern U.S. (Menzel et al. 2001). Within this range, the bats occupy two distinct types of habitat. During summer months, maternity colonies of more than 100 adult females roost under sloughing bark of dead and partially-dead trees of many species, often in forested settings (Callahan et al. 1997). Reproductive females may require multiple alternate roost trees to fulfill summer habitat needs. Adults forage on winged insects within three miles of the occupied maternity roost. Swarming of both males and females and subsequent mating activity occurs at cave entrances prior to hibernation (MacGregor et al. 1999). During this autumn period, bats roost under sloughing bark and in cracks of dead, partially-dead and live trees. Wintering colonies occupy very specific climatic regimes in cool, humid caves or mines primarily west of the Appalachian Mountains (Barbour and Davis 1969; Menzel et al. 2001). Few sites provide these conditions, and approximately 85% of the species inhabits only nine caves or mine shafts (Menzel et al. 2001; USDI FWS 1999).

Although most hibernacula have been protected, the Indiana bat still appears to continue a 5% decline in range-wide population every two years (Cochran et al. 2000). Causes of decline are not known and have continued despite efforts to protect all known major hibernacula. Researchers are focusing studies on land use practices in summer habitat, heavy metals, pesticides and genetic variability in attempts to find causes for the declines.

Recommended habitat management includes protecting known significant hibernacula from human impacts, retaining forested condition around the entrances to significant hibernacula, and evaluating opportunities to protect Indiana bats through land acquisition (Menzel et al. 2001).

It is difficult to quantify summer roosting habitat for Indiana bat at a range-wide, regional or local level due to the variability of known roost sites and lack of knowledge about landscape scale habitat characteristics. Forest management practices that affect occupied roost trees may have local impacts on Indiana bat populations. However, the bats live in highly altered landscapes, depend on an ephemeral resource--dead and dying trees--and may be very adaptable. Anecdotal evidence suggests that these bats may respond positively to some degree of habitat disturbance (USDI FWS 1999).

Several caves on the Forest have been known to support Indiana bats, at least historically. Steps have been taken by the Forest to protect these caves for the Indiana bat. Both males and females hibernate in large caves and mine tunnels. In 1995, bat gates were installed in several caves on the Forest. These caves are Shire's Saltpetre Cave on the New Castle Ranger District, and Kelly Cave and Cave Springs Cave on the Clinch Ranger District. Shire's Saltpetre Cave and Kelly Cave are the only caves on the Forest known to have been hibernacula for Indiana bats, at least historically. Cave Springs Cave is not currently known to be a hibernaculum for any rare bat species, but it has the potential to serve as a hibernaculum. In addition, Cave Springs Cave is known to contain a variety of troglobitic amphipods and isopods. Both forest-wide standards and a specific management prescription surrounding Indiana bat hibernacula are designed to protect roosting and foraging habitat as well as the hibernacula for the Indiana bat. The primary cave protection area is administratively unavailable for Federal oil and gas leasing. The secondary cave protection area is available for leasing with controlled surface use stipulations to protect Indiana bat habitat.

Potential impacts from gas drilling (including horizontal drilling and hydraulic fracturing) that could result from the decision to make lands available for leasing could include direct impacts to the hibernacula and impacts to foraging and roost trees from surface clearing operations. The hibernacula are protected since the Indiana Bat Primary Cave Protection Areas are unavailable for leasing. The Indiana Bat Secondary Cave Protection Areas are available only with Timing restrictions in alternatives A through G and with No Surface Occupancy stipulations in Alternative H. Most of the underground cave system would be under the primary protection area, and all would be under the secondary protection area, so it is very unlikely that the main borehole in any drilling would go through the cave system. However, this would be evaluated in the environmental analysis accompanying any site specific Application for Permit to Drill. In regard to effects to the cave from the horizontal drilling, the primary cave protection areas would not have any horizontal drilling underneath them. The secondary cave protection areas, while not allowing surface occupancy, would allow the use of horizontal drilling underneath them. It is unlikely that the horizontal drilling would directly affect any caverns above the drilling. The deepest cave in the area surrounding the GWNF is about 800 feet deep. The depth of drilling expected to develop gas resources in the area is estimated to be 1,000 feet to 8,000 feet. Any potential impacts to cave systems from drilling would be fully evaluated in the environmental analysis accompanying any site specific Application for Permit to Drill.

Potential impacts on foraging activities and roost trees from the clearing of well pads and pipelines would be addressed in the review of Applications for Permit to Drill when the site specific nature of these impacts can be best analyzed. Concerns about bats utilizing water from open impoundments with hydraulic fracturing fluids would be addressed in Alternative H by the standard requiring closed loop systems for those fluids.

Virginia big-eared bat (Corynorhinus townsendii virginianus). This bat has a very limited range in Virginia and on the Forest. It uses caves as both hibernation and maternity sites and none of the caves known to be currently used in Virginia or West Virginia are on the GWJNF. This bat is also called the Western big-eared bat and formerly was in the genus *Plecotus* (you may still see it referred to this way). This species is listed as

endangered both at the federal (1979) and state (Virginia, 1987) level, and as of July 1, 2005 it is officially the Virginia state bat. This bat is unique in that it is one of two bats in Virginia that uses caves almost exclusively during both summer and fall (the other species with a similar life history is the gray bat - Myotis griscesens). In Virginia this bat is currently only known to occur in Tazewell County (3 caves) during the summer and 5 caves in three counties (Tazewell, Bland, & Highland) during the winter. There are historic records in Rockingham, Bath, and Pulaski Counties. The area in Virginia where this bat is concentrated, and of greatest concern, is in the Tazewell County area where there are relatively large (~1,500 to 2,000 individuals) and well known winter hibernacula and a summer maternity caves. Elsewhere in Virginia the bat is/was known to occur in caves with just a few individuals (usually <10), probably as transients. The Virginia big-eared bat forages almost exclusively on moths and will feed over a wide variety of habitats including hay fields, corn fields, meadows, forests, etc. - wherever moths are found. Therefore, caves (and only a very few) are the key habitat element for this species. It forages widely over many different types of vegetation and foraging habitat is not critical, nor are moths in short supply. (Note: this is a species to closely consider in our gypsy moth related projects.)

Since no caves occupied by Virginia big-eared bats are located on the Forest, the only potential impacts of gas leasing would be on foraging activities. Effects could include changes in canopy structure and increases in ambient noise which could affect the ability of the bats to locate food. Concerns about bats utilizing water from open impoundments with hydraulic fracturing fluids would be addressed in Alternative H by the standard requiring closed loop systems for those fluids. Site specific impacts would be addressed in the review of Applications for Permit to Drill.

James spinymussel (*Pleurobema collina*). The James spinymussel was federally listed as endangered in 1988. Historically, this species was apparently throughout the James River above Richmond, in the Rivanna River, and in ecologically suitable areas in all the major upstream tributaries (Clarke and Neves 1984). The species remained widespread through the mid-1960s, but now appears extirpated from 90% of the historic range. Extant populations and historical habitats on or near the National Forest are displayed in Table 3-75. This species is found in slow to moderate currents over stable sand and cobble substrates with or without boulders, pebbles, or silt (Clarke and Neves 1984). Hove and Neves (1994) found James spinymussels in 1.5 to 20 m wide second and third order streams at water depths of 0.3 to 2 m. Seven fish hosts, all in the family Cyprinidae, have been identified (Hove 1990): bluehead chub, rosyside dace, blacknose dace, mountain redbelly dace, rosefin shiner, satinfin shiner, and stoneroller. Freshwater mussels are filter feeders taking organic detritus, diatoms, phytoplankton, and zooplankton from the water column.

The following excerpt from Hove and Neves (1994) states the current thinking on threats: "There are several anthropogenic and natural threats to the James spinymussel's continued existence. Nearly all the riparian lands bordering streams with the James spinymussel are privately owned. With more intensive use of the land, it is probable that water quality and habitat suitability will deteriorate. At present, the most detrimental activities include road construction, cattle grazing, and feed lots that often introduce excessive silt and nutrients into the stream."

The introduced Asian clam is also considered to be a threat to the James spinymussel and is beginning to invade several sites (Hove and Neves 1994). Despite extensive searches on the Jefferson National Forest, the James spinymussel has been confirmed at only one site. This consisted on one live specimen found in 1990 (O'Connell and Neves 1991). A subsequent survey in 2001 failed to locate any live specimens at this site. Based on this information it is uncertain that the Forest supports a viable population of James spinymussel. The main avenues for the Forest to aid in this species recovery are through land acquisition, assisting in augmentation efforts, and working with landowners to protect streams and streamside habitat. See section titled "Aquatic Viability Determinations for Oil and Gas Leasing"

Potential impacts from horizontal drilling and hydraulic fracturing that could result from the decision to make lands available for leasing could include contamination of water from spills or accidents, increased sedimentation from clearing and construction activities, and effects on the quantity of water in streams. The potential for these impacts to occur is reduced through the use of the riparian standards in all alternatives. Further protection is provided in Alternative H through standards added to keep all drilling facilities out of riparian areas and standards to require: no withdrawal of surface water or groundwater from NFS lands (unless specifically approved due to reduced overall environmental impacts); only closed loop systems for hydraulic

fracturing; removal of drill cuttings from the drill site and disposal at approved site off NFS lands; secondary containment infrastructure; and no surface disposal of flowback water or produced waters. Other site specific impacts would be addressed in the review of Applications for Permit to Drill when the site specific nature of these impacts can be best analyzed.

Madison Cave isopod (*Antrolana lira).* The closest known Madison Cave isopod occurrences to National Forest, and the majority of potential habitat on National Forest are on the Lee and Pedlar Ranger Districts; the lands on these Districts are not underlain by Marcellus shale and do not have a high potential for gas development. In Alternative H these lands are not being made available for oil and gas leasing. There are 15 acres of National Forest System lands along US Highway 250 in Augusta County, west of Churchville that intersect with medium probability isopod habitat. In Alternatives A, B, D, E, G, H and I these lands are in the Scenic Corridor Management Area Prescription (7B). The emphasis of the Scenic Corridor prescription is to provide high quality scenery in sensitive recreational and travelway settings. These corridors and viewsheds are suitable for federal oil and gas leasing with controlled surface use, with the exception of no leasing in Alternative I. In Alternative C, these lands are allocated to the Unsuitable Mosaics of Wildlife Habitat Management Area Prescription (13U) and are not available for leasing. In Alternative F, these lands are allocated to the Recommended National Scenic Area Management Area Prescription (4FA) and are not available for leasing. Concern for impacts to Madison cave isopod habitat from horizontal drilling and hydraulic fracturing from the decision to make these 15 acres available for leasing in Alternatives A, B, D, E, G, and H includes loss or modification of karst aquifer habitat, groundwater contamination, or groundwater drawdown. The potential for these impacts to occur is reduced through the use of the riparian standards and forestwide standards. In Alternative H additional protection is achieved by added standards to keep all drilling facilities out of riparian areas to require: no withdrawal of surface water or groundwater from NFS lands (unless specifically approved due to reduced overall environmental impacts); only closed loop systems for hydraulic fracturing; removal of drill cuttings from the drill site and disposal at approved site off NFS lands; secondary containment infrastructure; and no surface disposal of flowback water or produced waters. Other site specific impacts would be addressed in the review of Applications for Permit to Drill when the site specific nature of these impacts can be best analyzed.

Exploration and production activity would have minimal, if any, effects to any TES species that may occur in the area. Most effects would be associated with exploration and development activities that disturb or destroy habitat that supports the occurrence of a TES species. All activities that involve leases will require the preparation of a Biological Assessment and/or Biological Evaluation that determines effects on the TES species and outlines appropriate mitigation measures. TES species, no matter where they occur within the lease area, will be protected to ensure viable populations and suitable associated habitat. Controlled surface use and timing stipulations along with application of forestwide and specific standards will reduce or eliminate most adverse impacts. Generally, specific locations of exploration and production activity is flexible, so impacts to TES species can be avoided by relocating the development and confining disturbance to previously disturbed areas. Federally listed species will require compliance with the Endangered Species Act with species protection and recovery objectives outlined in the Recovery Plan prepared for each species. All known occurrences of federally listed plants on the Forest site are protected within Special Biological Areas. These areas are available for Federal oil and gas leasing with controlled surface use stipulations to protect the plants and their habitat as well as other rare biological resources.

For state listed species, the Forest will cooperate fully with the protection and recovery objectives set forth by the state. All alternatives include the general goal of contributing towards the recovery of federally listed threatened and endangered species (T&E). Additionally, the following activities are common across all alternatives:

- Recovery plans (when available) will be followed for all T&E species;
- Forestwide population objectives for threatened, endangered, and candidate plants will be followed;
- Forestwide standards will be followed. For example, “sites supporting federally listed threatened and endangered species or individuals needed to maintain viability are protected from detrimental effects caused by management actions”;

- Threatened, endangered, and sensitive species will be conserved through the site-specific biological evaluation process;
- Surveys for all TES and their habitats will continue to be conducted on the Forest, particularly as part of the biological evaluation process in conjunction with projects likely to affect habitat for the species (project-level surveys would be conducted in accordance with procedures outlined in the Region 8 supplement of Forest Service Manual 2672);
- Monitoring of known populations of threatened, endangered, and sensitive species will be conducted consistent with Forest Manual direction.

Wildlife

The physical effects of oil and gas leasing upon wildlife include elimination of individuals that cannot move out of existing habitats being impacted by construction or reconstruction of access roads, clearing and leveling of drill pad sites, construction of pipelines and facilities, and road traffic associated with large truck movements during active drilling and production phases. Site access is developed by building a new road or improving an existing one. The potential impacts from new gas well development on the Lee, North River, Warm Springs, and James River Ranger Districts would vary by alternative:

Table 3D-20. Gas Well Development (includes federal and private lease activity)

Oil and gas activity for vertical and horizontal wells	GWNF Baseline RFD	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Number of wells	319	307	250	54	249	92	198	93	177
Total reclamation (total disturbance) (acres)	2,555	2,457	1,433	434	1,432	446	768	453	685

Currently, there are no leases for Marcellus shale gas wells on the Lee, North River, Warm Springs, and James River Ranger Districts. Road and drilling pad construction would result in the creation of edge and a reduction of forest interior habitat. Creation of edge can result in an increase in cowbird parasitism and predation upon a variety of species. Given the Lee, North River, Warm Springs, and James River Ranger Districts are in a generally forested landscape, the expected negative impacts of edge are not considered significant. Forest interior habitat will be lost as a result of road construction and creation of drilling pads. This loss is considered to be similar for each alternative, thus habitat for the ovenbird, a forest interior management indicator species, will be reduced for all alternatives. Conversely, creation of edge and early seral habitat can benefit some species, such as white-tail deer, black bear, and wild turkey. Early successional bird species, such as indigo buntings, eastern towhees, and field sparrows may benefit from the resulting open and brushy habitats created from RFD of oil and gas resources. Habitat for the eastern towhee, an early successional habitat management indicator species, will be improved under all alternatives. Habitat for white-tailed deer, black bear, and wild turkey will be improved, but hunting opportunities could be limited near the well sites due to road traffic volume during active drilling and production phases.

Non-Native Invasive Plants

The Chief of the U.S. Forest Service (USFS) has identified non-native invasive species as one of the four critical threats to USFS ecosystems. As defined in Executive Order 13112 issued February 3, 1999, an invasive species is one that meets the following two criteria: “1) it is nonnative to the ecosystem under consideration and, 2) its introduction causes or is likely to cause economic or environmental harm or harm to human health.”

In the United States, invasive species are reported to be the second-most critical threat to conservation of biodiversity (Wilcove et al. 1998). Nonnative plants are known to occur across Southern and Central Appalachian forests, often accounting for 25% or more of the documented flora. While not all non-native

species are known to disrupt native ecosystems, of particular concern are those that are successful at invading and rapidly spreading through natural habitats. Invasive plants create a host of harmful environmental effects to native ecosystems including: displace native plants; degrade or eliminate habitat and forage for wildlife; threaten endangered species; impact recreation; affect fire frequency; alter soil properties; decrease biodiversity; and more. Invasive plants spread across landscapes, unimpeded by ownership boundaries. Infested areas represent potential seed sources for continuation of the invasion on neighboring lands.

Ground disturbance creates opportunities for establishment and spread of non-native invasive species. The amount of ground disturbance from new gas well development on the Lee, North River, Warm Springs, and James River Ranger Districts would vary by alternative:

Table 3D-21. Gas Well Development (includes federal and private leasing activity)

Oil and gas activity for vertical and horizontal wells	GWNF Baseline RFD	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Number of wells	319	307	250	54	249	92	198	93	177
Total reclamation (total disturbance) (acres)	2,555	2,457	1,433	434	1,432	446	768	453	685

Currently, there are no leases for Marcellus shale gas wells on the Lee, North River, Warm Springs, and James River Ranger Districts.

Ground disturbance caused by activities associated with Marcellus gas development includes road construction, well pad construction, pipeline construction and maintenance, and off-site facility construction. Ground disturbance creates habitat suitable for NNIP infestations. Roads and pipelines are corridors for NNIP to move through the landscape. The potential for NNIP infestation and movement increases with the amount of ground disturbance. Alternative A has the most acres of potential ground disturbance and therefore has the greatest potential for NNIP establishment. Alternatives B, D, and F would have 23% to 55% less ground disturbance than Alternative A and consequently as proportionately reduced threat of NNIP infestation. Alternatives C and I, E, and G would have a 283% to 565% reduced threat of NNIP infestation versus Alternative A. The potential for NNIP infestations from ground disturbing activities could be offset by specifying aggressive NNIP treatments when authorizing special use permits.

Potential Wilderness Areas and Inventoried Roadless Areas

Development of gas wells in areas of high gas potential could affect Potential Wilderness Areas and Inventoried Roadless Areas on the North River, James River and Warm Springs Ranger Districts. In Alternatives B, D, E, F, G, and H areas allocated to the Remote Backcountry Management Prescription Area would be leased with a no surface occupancy stipulation so there would be no impacts to those areas. Impacts would occur in those alternatives that would allow some form of "active management" in portions of the Potential Wilderness Areas or Inventoried Roadless Areas. These portions of lands would be administratively available under standard lease terms, timing stipulations and controlled surface use stipulations. However, for those portions that are in IRAs, in order for any exploration/development activities to be consistent with the 2001 RACR, they would have to be leased with stipulations that would prohibit any new road construction/reconstruction and limit the amount of tree removal that could occur. Table 3D-22 displays the Inventoried Roadless Area acres potentially affected by gas development by alternative.

Table 3D-22. Inventoried Roadless Areas Potentially Affected by Gas Development

Potential Wilderness Name	Potential Wilderness Area Acres	Inventoried Roadless Area Acres	Acres of Inventoried Roadless Area under Standard Lease Terms, Timing Stipulations or Controlled Surface Use Occupancy Stipulations							
			Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Archer Knob	7,100									
Beards Mountain	10,200	7,500	7,500							
Beech Lick Knob	14,100									
Crawford Knob	14,900	9,900	9,900	1,200		1,400				
Elliott Knob	11,100	9,400	9,400	200						
Galford Gap	6,700									
Gum Run	14,500	12,600	12,600							
High Knob	18,400	12,900	12,900	500						
Jerkemtight	27,300	16,800	16,800	800		800				
Laurel Fork	10,200	10,000	10,000							
Little Alleghany	15,400	10,200	10,200	700		1,000	1,000			
Little River	30,200	27,200	27,200	1000						
Oak Knob - Hone Quarry Ridge	16,300	10,800	10,800	800		1,200				
Oliver Mountain	13,000	13,000	13,000							
Paddy Knob	6,000									
Potts Mountain	7,000									
Ramseys Draft Addition	19,100	12,800	12,800							
Rich Hole Addition	12,200	10,900	10,900	1,500		1,500	1,500			
Rich Patch	900									
Rough Mountain Addition	2,100	1,200	1,200							
Shaws Ridge	7,300									
Total	264,000	165,200	165,200	6,700	0	5,900	2,500	0	0	0

Table 3D-23 displays those portions of the Potential Wilderness Areas (that are not in IRAs) potentially affected by gas development

Table 3D-23. Acres of Potential Wilderness Areas (That are Not in IRAs) Potentially Affected by Gas Development

Potential Wilderness Name	Potential Wilderness Area Acres	Inventor-ied Roadless Area Acres	Acres of Potential Wilderness Area (Not in IRAs) under Standard Lease Terms, Timing Stipulations or Controlled Surface Use Occupancy Stipulations							
			Alt A	Alt B	Alts C & I	Alt D	Alt E	Alt F	Alt G	Alt H
Archer Knob	7,100		7,100	7,100		7,100		7,100	2,200	2,000
Beards Mountain	10,200	7,500	2,600			1,800		1,800	1,800	1,900
Beech Lick Knob	14,100		14,100	8,500		8,500			5,800	4,900
Crawford Knob	14,900	9,900	5,000	5,000		5,000	2,500	2,500	5,000	5,100
Elliott Knob	11,100	9,400	1,700	1,700		1,700	1,700		1,700	4,400
Galford Gap	6,700		6,700	6,700		6,700	6,700		6,700	6,700
Gum Run	14,500	12,600	1,900	1,900		1,400				
High Knob	18,400	12,900	5,600	5,600		5,300			4,100	4,100
Jerkemtight	27,300	16,800	10,500	10,500		10,400	4,300	4,300	3,600	5,000
Laurel Fork	10,200	10,000	200	200						
Little Alleghany	15,400	10,200	5,200	5,200		5,200	5,200		5,000	5,100
Little River	30,200	27,200	3,000	3,000		2,400		2,400	1,500	1,400
Oak Knob - Hone Quarry Ridge	16,300	10,800	5,500	5,500		4,400				
Oliver Mountain	13,000	13,000	0							
Paddy Knob	6,000		6,000	6,000		5,100	5,100		5,100	5,000
Potts Mountain	7,000		7,000	7,000		7,000			7,000	6,700
Ramseys Draft Addition	19,100	12,800	6,300	6,300		5,400	4,700		3,400	3,600
Rich Hole Addition	12,200	10,900	1,200	1,200		1,200	1,200		1,000	1,000
Rich Patch	900		900	900						
Rough Mountain Add	2,100	1,200	900	900		800			900	800
Shaws Ridge	7,300		7,300	7,300		7,200				
Total	264,000	165,200	98,700	90,500	0	86,600	31,400	18,100	54,800	57,700

Development of gas wells and associated pipelines and roads in Potential Wilderness Areas would likely result in a loss of wilderness character in the area of the disturbance and could result in a loss of wilderness character in the entire Potential Wilderness Area.

Recreation

The Reasonably Foreseeable Development (RFD) for federal oil and gas uses the assumption that the entire is George Washington National Forest is open to federal oil and gas leasing except areas withdrawn by law, specifically designated Wildernesses and the Mount Pleasant National Scenic Area. The recreation opportunity settings of the national forest are inventoried using the Recreation Opportunity Spectrum (1986 ROS Book, USDA Forest Service). The spectrum of settings ranges from primitive to urban. Settings inventoried on the George Washington National Forest include semi-primitive non-motorized (SPNM), semi-primitive motorized

(SPM), roaded natural (RN), and rural (R). There are no areas on the Forest that meet the inventory criteria for the two extreme ends of the spectrum: primitive and urban.

There are approximately 995 miles of national forest system trails within the baseline RFD area, excluding trails in designated Wildernesses and the National Scenic Area. These trails are multiple-use, most allowing hiking, horseback riding and mountain biking. Three trails that total 65 miles allow motorized use. Hunting and some fishing are common dispersed recreation activities.

There are 59 developed recreation areas within the RFD area, and an additional 52 developed sites that support dispersed recreation.

Oil and natural gas development would affect recreation activities primarily in terms of the degree to which the settings and patterns of use are changed due to development operations. There are 847,566 acres, or 80% of the George Washington National Forest, in federal mineral ownership and not withdrawn from mineral leasing by law. Access road construction, gas well pad construction, gas pipeline construction and drilling operations could impact the developed and dispersed recreation visitors' experience and the recreation settings.

The sights and/or sounds of gas development activities may negatively impact the experience of recreationists using trails or recreating off-trail in the general forest area in the vicinity of lease activity, particularly during the drilling operation, pipeline construction and subsequent maintenance periods. A short-term result would be use pattern changes in the form of avoidance and displacement to other areas. A normal drilling operation would require about three months, beginning with site clearing and ending with site restoration. With production operations, the disturbance would normally be limited to the immediate area of the wellhead and the access road.

The RN setting allows human-made structures such as wellheads but these are generally scattered and remain visually subordinate from sensitive travelways. In the RN setting, remoteness is of little relevance due to the expected proximity to roads and/or facilities. However the semi-primitive settings provide opportunities for remote, backcountry recreation where there is little evidence of human-made structures other than trails and their associated signs and structures. Some vestiges from the past may be evident, but have been substantially reclaimed by nature. Examples include old narrow gauge railroad grades and logging roads. Within RN settings and given the latitude for well pad location contained in existing regulations, the negative impacts of leases can usually be mitigated during the production phase. Long-term, site restoration would allow the RN criteria to be met. Lease stipulations or Conditions of Approval on Surface Use Plans of Operations would ameliorate or eliminate impacts in some cases.

Within SPM and SPNM settings, a natural, unmodified environment should dominate. Areas of inventoried SPNM and SPM recreation settings that are allocated to prescription areas where federal oil and gas leasing is not available or would have a No Surface Occupation stipulation include Wilderness, recommended Wilderness, Appalachian Trail corridor, research natural area, designated National Scenic Area, recommended National Scenic Area and remote backcountry. These acres of semi—primitive settings are substantially protected and there would be little impacts to them.

In SPNM and SPM settings, there should be no permanent roads, on-site management controls should be subtle, and within SPNM areas there should be no motorized use. The construction, operations and maintenance of roads, wells, pipelines, their permanent presence in the setting, and the increased interactions between Forest visitors to these settings and lessees and contractors are not consistent with the experience characterization for SPM and SPNM. The table below shows acres of SPNM and SPM that are allocated to prescription areas that would be available for oil and gas leasing with either controlled surface occupancy, a timing stipulation or standard lease terms.

Table 3D-24. Summary of Semi-Primitive Settings Available for Oil and Gas Leasing With Surface Occupancy by Alternative

Stipulations and Terms	Alt A	Alt B	Alts C and I	Alt D	Alt E*	Alt F	Alt G	Alt H**
Controlled Surface Occupancy Stipulation, SPNM+SPM acres	5,856	5,615	0	5,395	5,367	5,320	5,384	75,016
Timing Stipulation, SPNM+SPM acres	656	0	0	659	659	659	659	0
Standard Lease Terms, SPNM+SPM acres	183,863	167,512	0	177,968	125,643	107,763	134,355	0
Summary of SP Acres Available for Oil and Gas Leasing	190,375	173,127	0	184,022	131,670	113,742	140,398	75,016

*Under Alt E, no horizontal drilling and associated hydraulic fracturing operations will be allowed.
**Under Alt H, all SPNM and SPM areas with a controlled surface use occupancy have a limit on road construction.

Based upon the baseline RFD, anticipated minerals activities and the resultant impacts from potential new gas well sites, associated roads, pipeline clearing and disturbance, following are the alternatives descending from greatest impacts to less impacts: Alternative A, Alternative D, Alternative B, Alternative G, Alternative E. Impacts may be mitigated by the Conditions of Approval on Surface Use Plans of Operations under all of the alternatives.

All of the developed recreation sites would be protected from direct effects of gas production by the Controlled Surface Use stipulations or Conditions of Approval on Surface Use Plans of Operations under all of the alternatives. However, there is some potential for recreationists to hear or see evidence of gas development activities taking place near the recreation site. These would normally be short- term impacts during production periods.

There is potential for roads and pipelines constructed to support oil and gas development and operations to impact trails and trail users. Direct impact to trails would occur in instances where access roads or pipelines cross them. Roads generate noise, dust, and safety concerns. Storm water runoff from roads and maintenance operations can potentially damage trails.

Alternatives C and I would have the least impact on trails, followed by Alternatives E and G. The alternative that would likely have the most impacts on trails is Alternative A. It has the greatest potential for occurrences of crossings or close proximity to trails that would impact trails and trail users. The alternatives with the next greatest potential for impacts to trails are Alternatives B and D. These effects may be mitigated, to varying degrees, through rehabilitation, management controls, and/or trail relocation. Lease stipulations or Conditions of Approval on Surface Use Plans of Operations would ameliorate or eliminate impacts in some cases.

As of September 2010, existing federal oil and gas leases were in effect on 1.2% of the George Washington National Forest lands. Considering both potential federal leases and potential private minerals development on national forest land, and the resultant impacts from expected new gas well sites, associated roads, pipeline clearing and disturbance, Alternative A would have the greatest impacts on recreation resources, followed by Alternative D.

Scenery

The scenic resource is affected by management activities altering the appearance of what is seen in the landscape. Short-term scenic effects are usually considered in terms of degree of visual contrast with existing or adjacent conditions that result from management activity. The scenic landscape can be changed over the long-term or cumulatively by the alteration of the visual character. Management activities, which result in visual alterations inconsistent with the assigned SIO, even with mitigation, affect scenery. Management activities that

have the greatest potential of affecting scenery are road construction, vegetation management, insect and disease control, special use utility rights-of-ways, and mineral extraction.

Mineral management and development activities can involve major alteration to landform, as well as contrasts to form, line, color, and texture, causing substantially adverse scenic impacts. Natural gas drilling and production are not common on the George Washington National Forest. To date there have been only five exploration wells and no wells have gone to production. Currently, the activities associated with minerals involve shale pits, limestone extraction and surface collection of building rock. New activities associated with federal oil and gas leasing will impact scenery.

The most significant visual impacts from natural gas well development would occur during the drilling operation and subsequent maintenance periods. Drilling rigs and other equipment would give the area an industrial look that is out of character with the surrounding landscape. The negative visual impacts from drilling would include the construction of well pads, access roads and pipelines along with the operation and sight of the necessary drilling equipment. A normal drilling operation would require several months, beginning with site clearing and ending with site restoration. The areas are moderate to steeply slope and there may be some steep cut slopes that would likely be necessary in the construction of roads and well pads. The following table shows the potential development of roads, pipelines, and well pads by alternative.

Table 3D-25. Oil and Gas Leasing Activities by Alternative That Affect Scenery (includes federal and private leasing activity)

Activity	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Roads (miles)	237	120	42	119	32	47	32	42
Pipelines (miles)	260	131	46	131	35	52	35	46
Well pad (acres)	597	486	106	486	183	386	185	344

Based upon the Reasonably Foreseeable Development (RFD) scenario, potential minerals activities and the resultant impacts from expected new gas well sites, associated roads, pipeline clearing and disturbance to soils, the alternatives rank, in descending order, from the greatest impacts to the least impacts as follows:

Alternative A, B, D, H, F, and E. Related to oil and gas leasing, Alternatives C and I would have no impact on scenery.

Potential maximum direct, indirect and cumulative effects to scenery resources can be assessed according to the maximum extent within which the characteristic landscape is altered, including changes to line, color, texture and scale. Ground-disturbance, grading and vegetation clearing activities can potentially occur for all alternatives except Alternatives C and I. The principal proposed activities that could alter the characteristic landscape include construction of roads, well pads and pipelines. Cumulatively, the repeated implementation of these project activities could, over time, result in the degradation of scenery.

Cultural Resources

The George Washington National Forest contains a multitude of sites representing past human events. Beginning with Native American occupations dating as early as 8000 B.C., the variety of cultural resources is impressive. Prehistoric sites include multi-use base camps, transient camps, hunting and gathering stations, quarries, lithic reduction stations, and rock-shelter occupations. The most common site type is often referred to as a lithic scatter and represents a short-term occupation where stone tools were made and/or sharpened and may be associated with a plethora of ancillary activities. Native American sites are found throughout the Forest for all time periods with the exception of the Ice Age Paleoindians. Unknown Paleoindian sites may exist on the Forest but have yet to be located. Cultural resources are important resources that require inventory, evaluation, protection, and interpretation.

Direct and indirect affects to historic or cultural resources could result from both natural and human-caused events. These vary depending upon the type of resource, the fragility of the resource, and the type of disturbance, but could include soil disturbance to varying depths, vegetation removal, looting or vandalism, and land use changes.

Accordingly, five types of ground disturbing land management activities that vary in magnitude (acres or miles) have the greatest potential to affect cultural resources. These include: timber management, road construction, fire management, mineral management, and recreation use. To a lesser degree, other forms of land management, such as landownership adjustment (land exchange), special use permits, structures management, and wildlife management can also affect cultural resources.

Exploration and development of leasable minerals, oil, gas, and mineral materials may impact cultural resources through access road construction, pipeline construction, well pad placement, and actual removal and displacement of minerals and soil. Mineral extraction may produce severe, albeit localized, direct effects to significant cultural resources as the overburden containing historic resources are removed. Indirect effects could include damage to significant cultural resources located outside the area of immediate mining resulting from erosion, the installation of road accesses and equipment staging areas, and vandalism and looting resulting from increased access to these historic properties.

Apart from these common effects, potential maximum direct, indirect and cumulative effects to cultural resources can be assessed according to the maximum extent within which ground-disturbing activities can potentially occur for each alternative. The principal proposed ground-disturbing activities include construction of roads and well pads. Cumulatively, the repeated implementation of these project activities could, over time, result in the degradation of sites, a potential reduction in the number of intact historic properties, and increased site vandalism.

Analysis of effects of minerals management to significant cultural resources is performed programmatically in compliance with existing laws and regulations (e.g., 36 CFR 296, 800, and the PA with the Virginia SHPO) and occurs on a case-by-case basis separate from alternatives. Therefore, effects to cultural resources resulting from minerals management are not affected by alternative.

Mineral Resources

The combustion of fossil fuels in the drilling, hydraulic fracturing, and production of vertical and horizontal wells for natural gas is evaluated in a recent Environmental Impact Statement by New York State (New York State Department of Environmental Conservation 2011). Data from the report is used to estimate the diesel/gasoline consumption of drilling, hydraulic fracturing, and production of vertical and horizontal wells for natural gas by alternative.

Table 3D-26. Estimated diesel/gas consumption for federal oil & gas lease operations (thousands of gallons)

Decade	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Decade 1 annual average	802	553	0	553	68	421	69	400
Decade 1 total	8,020	5,531	0	5,531	678	4,217	692	4,002
Decade 2 annual average	807	818	0	818	81	485	71	386
Decade 2 total	8,074	8,178	0	8,178	809	4,847	710	3,864
Decade 3 annual average	19	206	0	206	24	127	17	87
Decade 3 total	1,899	2,060	0	2,060	243	1,268	167	871

In addition to consumption by combustion, natural gas is lost by fugitive emissions, venting and flaring. These losses are expected to vary by alternative in a similar way as the alternatives vary by diesel/gasoline consumption.

The cumulative consumption of gasoline/diesel by potential federal oil and gas operations is shown and added to the subtotal in Table 3D-26.

Table 3D-27. Estimated gas/diesel consumption for decade 1 (millions of gallons)

Program	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Forest Administration*	1.0	1.2	0.7	1.9	1.2	0.9	1.2	1.2
Timber Harvest	6.6	7.8	0.0	14.8	4.4	2.7	7.7	7.7
Recreation*	40.0	41.0	36.0	40.0	36.0	44.0	41.0	41.0
SubTotal	47.6	50.0	36.7	56.7	41.5	47.6	50.0	50.0
Potential Federal Oil & Gas	8.0	5.5	0.0	5.5	0.7	4.2	0.7	4.0
Total	55.6	55.6	36.7	62.2	42.2	51.8	50.7	54.0

*Based on midpoint of range in annual gas/diesel consumption tables

Social and Economic Resources

INTRODUCTION

The Reasonably Foreseeable Development (RFD) of federal oil and gas leasing on the GWNF concentrated on development of the Marcellus shale formation; therefore, this section focuses on potential effects from development of that formation. Development of the Marcellus shale gas play on and near the George Washington National Forest would bring natural gas drilling and production activity to areas that have seen little or no such activity in the past. Descriptions of the existing social and economic environments for the GWNF at local and regional levels are presented previously in Chapter 3, Section C12, Social and Economic Impact Analysis. This section describes the potential effects of Marcellus shale development on social characteristics, such as demographics and quality of life, and on economic characteristics, such as employment, income, economic diversity and federal payments.

There are a number of factors to consider when determining the social and economic impacts resulting from the extraction of natural gas. Kay (2011) suggests that the most important factors are related to pace and scale, i.e. the rate of development, the length of time over which the development occurs, and the geographic distribution of the development. Christopherson (2010) lists the following factors that may affect the pace and scale of Marcellus Shale drilling: transportation costs; current tax policies; speculative investments; competition among and access to capital by natural gas companies; rig availability; regulatory requirements and capacity; and status of other natural gas sources, such other deep shale plays. Kay (2011) identifies various drivers for the pace of drilling that include: the need to initiate production or risk losing it or having to renegotiate leases on less favorable terms (hold by production); futures markets for gas; production incentives related to joint venture agreements; the internationalization of capital investment in shale gas drilling; capitalization strategies that emphasize production over profit; well drilling technology; Marcellus productivity; and regional geology. Considine (2010b) adds geology differences and politics to the list. Christopherson and others (2011a) give two ways to forecast the pace and scale of drilling in a shale gas play. The first is based on what is geologically and technologically possible: an analysis of total potential natural gas reserves and the

capacity of existing or anticipated technologies. The other is based on business dynamics in the energy industry, and looks at what are the likely strategies of energy firms in response to their profit opportunities in particular shale plays and overall.

AFFECTED ENVIRONMENT

There is no current development of any natural gas formations on the GWNF. Although there are existing federal leases and private mineral rights within the Forest, there are no known future plans for development.

Current economic and social characteristics of the 17 counties with GWNF lands are described in Chapter 3, Section C12. Of particular interest, are five Virginia counties where there is over 20% of the total county acreage in GWNF lands underlain by Marcellus shale resources. These counties include: Alleghany (30%), Augusta (23%), Bath (28%), Highland (22%) and Rockingham (22%). Similarly, Pendleton County, West Virginia has 11% of the total county acreage where the Marcellus shale underlies GWNF lands. Botetourt, Page, Rockbridge, Shenandoah Counties in Virginia and Hampshire and Hardy Counties in West Virginia have between 1% and 3%. The following table highlights some of the current social and economic indicators for the counties with more than 10% of total acreage of GWNF lands with Marcellus shale. Although the geographical distribution of wells and the inter-relationships between counties would be influencing factors, these counties may be the ones that experience a higher degree of additional incomes, job opportunities, federal payments and other benefits as well as negative effects such as competition for tourism businesses and strains on infrastructure and landscape amenities if development occurs on GWNF lands in those counties.

Table 3D-28. Counties with More than 10% of Total Acreage that have GWNF Lands with Marcellus Shale Resources.

County or Independent City	Per Capita Income in 2010	Unemployment Rate in 2011	People Below Poverty in 2010	Employment in Travel and Tourism Sector in 2009	Forest Service Payments (2011$)
Alleghany County, VA	$22,013	8.3%	13%	18%	332,179
Covington city, VA	$20,781	9.2%	n/a	15%	n/a
Augusta County, VA	$23,571	6.0%	12%	9%	459,872
Staunton city, VA	$24,077	6.9%	n/a	19%	n/a
Waynesboro city, VA	$23,190	7.9%	n/a	19%	n/a
Bath County, VA	$22,083	5.4%	10%	45%	394,192
Highland County, VA	$25,690	7.0%	9%	18%	118,499
Rockingham County, VA	$25,274	5.5%	18%	13%	430,551
Harrisonburg city, VA	$16,750	7.3%	n/a	23%	n/a
Pendleton County, WV	$19,401	6.5%	15%	18%	401,776

DIRECT AND INDIRECT SOCIAL AND ECONOMIC IMPACTS

SOCIAL

The potential social impacts of Marcellus shale development include both positive and negative effects on indicators of community, such as population, housing, local government services, and quality of life. The magnitude of these effects can vary based on the overall pace and scale of natural gas development. Since gas drilling on the GWNF would be a new industry in the local economy, a sizeable start of development could have concerns for localized and abrupt effects on housing markets, tourism, community services and infrastructure.

Increased demand for housing from nonlocal gas workers could bring in additional income, but it could also increase rates that are no longer affordable to local residents or tourists (Alter et al. 2010). A less diversified local economy could experience competition for resources related to housing, labor or materials, resulting in a 'crowding out' effect, such as availability of hotels versus tourists (Kay 2011).

Tourism-related businesses, such as restaurants, hotels and shopping venues, can benefit from an influx of nonlocal gas industry employees. However, the industry's demand for these businesses could strain the ability of these businesses to provide services for local residents and visitors (Kay 2011; Christopherson et al. 2011a).

The visual impacts of drilling are related to the well pads, drilling rigs, compressor stations, water storage, equipment depots, access roads, pipelines, etc. Drilling rigs can reach a height of 150 feet or more, but the degree of impact can vary depending on viewing distance and surrounding landscape character. During the drilling phase, these rigs operate 24 hours a day, creating night time impacts that include rig lighting and open flaring. On a small scale, the impacts may be insignificant but cumulatively, the greater the extent of drilling, the greater the potential of changing the visual environment from a scenic landscape to a more industrial landscape (Rumbach 2011).

The rural and outdoor amenities that are associated with environmental tourism often provide a key attraction for visitors as well as young professionals and retirees who move to an area. Outdoor recreation and sporting amenities (hunting, fishing, and water-related activities) contribute to an area's quality of life, or community character. The preservation and maintenance of those amenities can be an important component of an area's sustainable economic development strategy (Rumbach 2011). Therefore, if the environmental impacts from natural gas development become negative, an area may suffer decreases in tourism or population growth.

Christopherson and Rightor (2011b) note that while access roads to well sites are usually adequately designed, constructed and maintained, there are other roads that are used by the trucks that are not designed to withstand the volume, weight and dust associated with this level of truck traffic. This could be mitigated to some extent through weight permitting, bonding provisions and other methods by local communities but there could be additional social and economic effects on local governments and residents.

Another positive social effect from natural gas production comes from the eventual use of a relatively clean source of energy. A reduction in the demand for oil or coal would result in a decrease in carbon dioxide emissions and other air pollutants such as sulfur and nitrogen (Kinnaman 2010).

ECONOMIC

Economic impacts include potential effects on employment, income, revenues and expenditures. The typical methodology for evaluating economic impacts involves the use of an input-output economic impact model that measures how different amounts of a product or service create direct, indirect and induced effects on employment and income. Most of the studies estimating the economic impacts from Marcellus shale development have used the IMPLAN (Impact for Planning Analysis) model, which is the model the Forest Service uses. IMPLAN is an economic model originally developed by the Forest Service, Federal Emergency Management Agency and the Bureau of Land Management. IMPLAN has since been privatized and is now provided by Minnesota IMPLAN Group (MIG). It uses a database of economic statistics obtained from major government sources such as the Regional Economic Information System (REIS), Bureau of Economic Analysis, Bureau of Labor Statistics and US Census Bureau.

There are a number of studies that have addressed the economic impacts of the Marcellus shale industry through the use of input-output economic models: The Perryman Group 2008; Considine 2010b; Considine, Watson, and Blumsack 2010a; Barth, 2010; Higginbotham 2010; and Kelsey and others 2011. However, since Marcellus shale drilling using high-volume hydraulic fracturing techniques is a relatively new industry that has become established rather rapidly in some areas, some of these studies have been subject to various criticisms, such as lack of extensive experience and empirical data (Kay 2011; Kinnaman 2010) or assumptions made concerning the amount of leakage for a newly developing industry in a region (Kay 2011; Kelsey 2011; Kinnaman 2011). Another caution for comparing these studies to the potential effects on the

local economy for the GWNF area is that all of these studies assumed that the gas development and production occurred on private lands, not public lands. Income that is derived from leasing fees, bonuses and royalties to private landowners (including how those landowners then spend that money) can differ from those made to the Unites States Treasury on public lands. Despite criticisms concerning these studies, they are worth mentioning because they all show substantial increases in jobs and income from development of the Marcellus shale gas play.

EMPLOYMENT

In 2009, the Marcellus Shale Education and Training Center conducted a Marcellus Shale Workforce Needs Assessment (MSETC 2009). They identified three labor forces associated with the development of Marcellus shale: direct, indirect and induced labor. Direct labor jobs are directly involved in the drilling and production phases. These direct labor jobs include occupations associated with staking, scoping, permitting, engineering, logging, clearing, drilling, moving, finishing, cementing, completing, fracturing, and producing a well, as well as the majority of jobs required to clear, dig, and construct collector pipeline and compressor station infrastructure for the well. Indirect labor includes the supply-chain industries such as quarries, real estate, machinery manufacturers, etc. Induced labor includes such items as housing, food and drink, and retail, when purchased from household spending of income earned either directly or indirectly from the industry spending.

The drilling phase of gas development typically depends on a workforce that is out of the region of development, except for truck haulers and construction jobs. The majority of drilling phase jobs include the ‘roughnecks’ who work on drilling rigs, excavation crews, CDL (tractor-trailer) drivers, heavy equipment operators, hydro-fracturing equipment operators, and semi-skilled general laborers. Development of the Marcellus shale is more industrial in nature, technologically advanced and labor intensive than the more traditional shallow natural gas drilling (Christopherson et al. 2011a). The production phase tends to rely on local employment that include well operators, instrumentation technicians, pipefitting and welding technicians, production engineers, and office staff (Christopherson et al. 2011b; Jacquet 2011). The Marcellus Shale Education and Training Center assessment (MSETC 2009) found that 98% of jobs are concerned with the development of the gas well and are not needed after the well has been drilled. Only 2% of jobs are concerned with the long-term production of the well. However, as the gas industry becomes more established in a region, the workforce may become more local as training opportunities develop in the region, companies may set up operations closer to the region and nonlocal employees may relocate to the region (Jacquet 2011).

The MSETC also performed a number of regional workforce needs assessments focused on the Marcellus shale gas industry in Pennsylvania. They have found that approximately 250 different occupations comprised of over 400 different individuals are required to drill a Marcellus Shale well. However, a typical high-volume hydraulic-fracturing well is constructed over a three to four month period. The vast majority of these individuals and occupations are required for only a few hours or days for each well. The number of Full Time Equivalent (FTE) workers (an FTE is equal to one worker working full time for a year) for these 410 individuals was about 13 FTEs to complete a well. Only one FTE is required to operate and maintain every six wells in production but that FTE is needed for the life of the wells, about 30 years (MSETC 2009, 2010).

To identify the contribution to employment from Marcellus shale gas development on the GWNF, the IMPLAN model was used to identify the economic linkages among the industrial sectors within the local economy and how those industries respond to the development. For purposes of estimating the economic impact on jobs and labor income from natural gas development, the counties and their independent cities that contain GWNF acreage were selected as the impact area for the IMPLAN model. However, estimating the impacts from new development of a gas play using the IMPLAN model can be different than estimating the impacts from other resource outputs, such as timber and recreation which can be predicted at a fairly steady rate over a time period and based on historical data. Input-output analysis relies on tables of coefficients that link one industry to all other industries. In a region where gas drilling has not existed in the past, it is impossible to know what those area-specific inter-industry coefficients will be, and “borrowing” them from other regions or industries can result in inaccurate impact conclusions. The most important use of the model for our local economy is to compare relative economic effects among the alternatives. The results should not be viewed as absolute economic values that accurately portray the infinitely complex economic interactions of the regional economy.

Tables 3D-29 and 3D-30 illustrate how the proposed alternatives potentially affect jobs in the local economy for the GWNF. The table represents the jobs from outputs from other resource outputs as described in Chapter 3, Section C Tables 3C12-19 and 3C12-20, plus development of Marcellus shale gas on federal and private leases within the GWNF. In the IMPLAN model, jobs can be part-time, full-time or seasonal. Currently, there are 857 jobs related to the Minerals industry within the local economy (Chapter 3, Section C, Table 3C12-6), none of which are influenced by activities on the GWNF since there is no current gas production on GWNF lands. As the table below shows, the development of Marcellus shale on the GWNF would significantly increase the numbers of jobs.

Table 3D-29. Employment by Resource Activity by Alternative (Average Annual, Decade 1, jobs contributed), with Marcellus Shale Gas Development on GWNF lands (includes development on existing federal leases and private mineral rights)

Resource	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Recreation	78	79	67	83	74	83	80	80	80
Wildlife and Fish	52	53	44	55	49	55	54	54	54
Timber	88	106	0	199	60	38	106	110	110
Minerals	2,978	2,255	536	2,255	763	1,850	767	1,775	536
Payments to States/Counties	64	64	64	64	64	64	64	64	64
Forest Service Expenditures	351	321	299	332	318	314	322	322	322
Total Forest Service Management	3,611	2,878	1,011	2,989	1,328	2,404	1,393	2,404	1,166

Employment divided among the major industrial sectors of the local economy is shown in the following table. For more information on the definition of the industrial sectors, see the Economic Affected Environment section in Chapter 3, Section C12. The development of natural gas under each alternative has by far the greatest impact on employment than any other resource activity on GWNF lands.

Table 3D-30. Employment by Major Industry by Alternative (Average Annual, Decade 1, jobs contributed), with Marcellus Shale Gas Development

Industry	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Agriculture	67	76	6	125	45	33	75	77	77
Mining	2,365	1,789	427	1,789	604	1,467	607	1,409	427
Utilities	4	3	1	4	2	3	2	3	2
Construction	103	78	23	79	29	65	29	63	26
Manufacturing	17	20	3	39	10	10	16	19	18
Wholesale Trade	29	24	11	26	15	21	16	22	15
Transportation & Warehousing	34	28	12	31	16	24	18	25	16
Retail Trade	146	120	58	128	75	106	80	107	76
Information	8	7	3	7	3	6	4	6	5
Finance & Insurance	42	34	12	36	16	28	17	28	15

Industry	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Real Estate & Rental & Leasing	51	40	15	43	21	34	22	34	18
Prof, Scientific, & Tech Services	74	57	19	59	26	48	27	47	22
Mngt of Companies	12	10	2	10	4	8	4	8	3
Admin, Waste Mngt & Rem Service	40	33	13	35	17	27	18	28	15
Educational Services	14	11	4	12	5	9	6	10	5
Health Care & Social Assistance	102	80	28	86	40	66	43	68	35
Arts, Entertainment, and Recreation	36	33	21	35	24	31	26	31	24
Accommodation & Food Services	115	100	58	107	71	93	76	93	64
Other Services	59	47	16	51	22	38	24	40	19
Government	292	288	280	289	283	286	284	287	283
Total Forest Management	3,611	2,878	1,011	2,989	1,328	2,404	1,393	2,404	1,165

INCOME

The spending by Marcellus producers has ripple effects throughout the economy. For example, drilling companies hire trucking firms to haul pipe, water, and other materials to a well site. This trucking firm buys fuel and other supplies to supply these services and hires drivers to operate the trucks. The truck suppliers in turn acquire goods and services from other firms, such as repair shops, parts distributors, and other suppliers. So Marcellus investment sets off a business-to-business chain of spending throughout the economy. These economic impacts are known as *indirect* impacts. When the drivers go out and spend their paychecks, that spending stimulus sets in motion a similar chain reaction, known as *induced* impacts (Considine 2010a). There are also several byproducts of processed gas such as ethane, propane, butanes that can be used as raw materials and/or final products by other local industries. Higginbotham (2010) further identified a non-quantifiable economic impact of the natural gas industry as the community partnerships that many companies have with local schools, service departments, associations, clubs and charitable organizations.

IMPLAN was also used to estimate income generated from developing Marcellus shale on the GWNF. Labor income is employee compensation (value of all wages and benefits) plus the income to sole proprietorships. The average annual labor income for the first decade for each resource program expenditure is given by alternative in Table 3D-31. Impacts to the local economy industries are shown in Table 3D-32. For more information on the definition of the industrial sectors, see the Economic Affected Environment section in Chapter 3, Section C12. As with employment, the development of natural gas has by far the greatest impact on labor income than any other resource activity on GWNF lands.

Table 3D-31. Labor Income by Program by Alternative (Average Annual, Decade 1, thousands of 2012 dollars), with Marcellus Shale Gas Development

Resource	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Recreation	$2,030	$2,061	$1,754	$2,173	$1,945	$2,169	$2,104	$2,105	$2,105
Wildlife and Fish	$1,417	$1,439	$1,204	$1,515	$1,351	$1,512	$1,468	$1,468	$1,468
Timber	$2,426	$3,011	$0	$5,845	$1,674	$1,049	$3,011	$3,114	$3,114
Minerals	$90,163	$68,962	$16,031	$68,962	$23,941	$56,525	$24,033	$53,900	$16,031
Payments to States/Counties	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593	$2,593
Forest Service Expenditures	$16,544	$12,058	$8,794	$13,608	$11,540	$11,010	$12,123	$12,126	$12,126
Total Forest Management	$115,173	$90,124	$30,376	$94,696	$43,043	$74,857	$45,332	$75,307	$37,437

Table 3D-32. Labor Income by Major Industry by Alternative (Average Annual, Decade 1, thousands of 2012 dollars), with Marcellus Shale Gas Development

Industry	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Agriculture	$1,694	$1,953	$84	$3,298	$1,147	$786	$1,946	$1,989	$1,989
Mining	$68,601	$52,561	$12,182	$52,561	$18,333	$43,079	$18,401	$41,037	$12,182
Utilities	$649	$510	$184	$539	$246	$427	$258	$431	$227
Construction	$3,640	$2,746	$794	$2,771	$1,006	$2,278	$1,022	$2,228	$926
Manufacturing	$873	$969	$173	$1,860	$508	$509	$787	$950	$894
Wholesale Trade	$1,640	$1,381	$648	$1,478	$844	$1,217	$907	$1,225	$1,211
Transportation & Warehousing	$1,650	$1,370	$529	$1,490	$746	$1,155	$806	$1,176	$591
Retail Trade	$3,858	$3,162	$1,525	$3,334	$1,944	$2,806	$2,064	$2,813	$1,855
Information	$417	$336	$132	$351	$172	$286	$180	$285	$156
Finance & Insurance	$1,770	$1,405	$488	$1,467	$670	$1,174	$702	$1,172	$523
Real Estate & Rental & Leasing	$724	$576	$222	$598	$292	$488	$303	$486	$254
Prof, Scientific, & Tech Services	$3,349	$2,575	$850	$2,640	$1,140	$2,155	$1,173	$2,127	$993
Mngt of Companies	$851	$656	$171	$668	$244	$539	$250	$524	$199
Admin, Waste Mngt & Rem Services	$890	$719	$283	$754	$370	$610	$387	$610	$302
Educational Services	$457	$358	$123	$376	$172	$298	$181	$300	$159
Health Care & Social Assistance	$4,085	$3,197	$1,126	$3,364	$1,578	$2,666	$1,661	$2,689	$1,377
Arts, Entertainment, and Recreation	$464	$423	$276	$445	$324	$409	$348	$402	$325
Accommodation & Food Services	$1,906	$1,665	$980	$1,756	$1,182	$1,556	$1,265	$1,543	$1,144
Other Services	$1,790	$1,420	$487	$1,506	$684	$1,174	$728	$1,193	$562
Government	$15,866	$12,142	$9,118	$13,441	$11,441	$11,245	$11,963	$12,128	$10,694
Total Forest Mgt	$115,173	$90,124	$30,376	$94,696	$43,043	$74,857	$45,332	$75,307	$36,563

FEDERAL ROYALTIES AND STATE TAXES

Under the Mineral Leasing Act of 1920, royalties are paid to the federal government for oil and gas production from public lands. Royalties are paid at 12.5 percent of production value. This would result in the following royalties under each alternative. From the federal mineral royalties, 25% are returned to the state where the activity occurred. Additional outputs would occur as federal revenue from bonus bids, annual lease rentals, and State and counties 25% share of these federal revenues. Other outputs include severance tax revenue to state or counties and *Ad valorem* property taxes on production and field equipment.

Table 3D-33. Federal Royalties from Marcellus Shale Development by Alternative (million $)

	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Federal revenue production royalty	$365	$282	$0	$282	$21	$210	$21	$177

Virginia has a severance tax that returns 3% to the producing county. West Virginia has a 5% severance tax. Assuming that development on private lands would occur with development on GWNF lands, there would also be increases in real property taxes, personal property taxes, sales and use taxes, corporation income taxes, permits, bonds and other environmental taxes or fees. The Virginia Oil and Gas Association reports that the production of conventional natural gas and coalbed methane, occurring almost exclusively in the southwest region of the state, resulted in 102.9 billion cubic feet of gas in 2006, with about $16,000,000 paid to those counties from severance taxes.

ECONOMIC EFFICIENCY

Present net value (PNV) is the measure used to calculate economic efficiency and highlights the differences among alternatives in the long-term value of management activities. Table 3D-34 represents the PNV from other resource outputs as described in Chapter 3, Section C Table 3C12-24, plus development of Marcellus shale gas on federal and private leases within the GWNF.

Table 3D-34. Cumulative Decadal Present Net Values of Benefits and Costs with Development of Marcellus Shale (millions of dollars, 4% discount rate cumulative to midpoint of 5th decade)

Program	Alt A	Alt B	Alt C	Alt D	Alt E	Alt F	Alt G	Alt H	Alt I
Present Value Benefits by Program:									
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$36	$71	$0	$145	$36	$21	$62	$67	$67
Minerals	$23,826	$18,992	$4,230	$18,992	$5,389	$15,256	$5,421	$13,808	$4,230
Recreation	$1,162	$1,181	$1,007	$1,242	$1,111	$1,244	$1,205	$1,206	$1,206
Wildlife	$661	$668	$562	$713	$640	$698	$684	$684	$684
Total Present Value Benefits	$25,685	$20,912	$5,799	$21,093	$7,177	$17,220	$7,373	$15,765	$6,187
Present Value Costs by Program:									
Range	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1	<$1
Timber	$55	$69	$0	$106	$47	$36	$69	$69	$69
Roads/Engineering	$73	$46	$43	$48	$46	$45	$46	$46	$46
Minerals	$5	$5	$4	$6	$5	$5	$5	$5	$5
Recreation	$151	$91	$99	$107	$91	$97	$93	$93	$93
Wildlife	$38	$16	$10	$17	$16	$16	$16	$16	$16
Soil, Water and Air	$38	$18	$19	$17	$18	$18	$18	$18	$18
Protection/Forest Health	$27	$49	$32	$38	$55	$50	$49	$49	$49
Lands	$37	$11	$11	$10	$11	$11	$11	$11	$11
Planning, Inventory, Monitoring	$9	$10	$11	$10	$12	$10	$10	$10	$10
Total Present Value Costs	$433	$315	$230	$356	$302	$288	$317	$317	$317
Cumulative Total Present Net Value	$25,252	$20,597	$5,569	$20,737	$6,875	$16,932	$7,056	$15,448	$5,870

SUMMARY OF DIRECT AND INDIRECT SOCIAL AND ECONOMIC EFFECTS

Natural gas development would provide jobs, increase economic investments and outputs, and increase federal receipts to the United States Treasury and to the local states and counties. It could also stress community services and infrastructure, as well as affect the quality of life and landscape character of a community or region. Potential changes can be viewed as being either positive or negative. For example, in a study of Pennsylvania residents, Alter and others (2010) concluded that most described the development of the Marcellus shale in their area as a chance for 'economic revival', but raised concerns about the potential costs to various segments of the community, infrastructure and the natural environment. For some residents, the industry could bring jobs, capital investments and increased income but for others, it could bring threats of social upheaval and possible environmental problems, declining social well-being and a decreased quality of life. However, most participants in their study were hopeful that communities could develop strategies and tools for managing growth, generating taxes for local jurisdictions, and developing training programs for entry level gas industry jobs.

As mentioned previously, the pace and scale of drilling is the most critical determinant in the magnitude of social and economic impacts to a region. Table 3D-35 provides a comparison of the possible pace and scale of development reflected in each of the nine FEIS alternatives and the Reasonably Foreseeable Development (RFD) Scenario on GWNF lands over the next 15 years. Common to all alternatives are development of: 1)

private mineral rights on GWNF lands; and 2) existing federal oil and gas leases. The potential of federal oil and gas activity on federal mineral ownership will vary by alternative.

Table 3D-35. Activities Associated with Gas Well Development for Each Alternative and the Reasonably Foreseeable Development Scenario (includes existing federal leases and private mineral rights).

Activity	Baseline RFD	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Exploration/Evaluation Wells (vertical)	20	19	16	3	16	14	12	14	11
Development Wells (vertical)	50	48	39	9	39	35	30	36	28
Development Wells (horizontal)	249	240	195	42	195	42	156	42	138
Total Wells	319	307	250	54	249	92	198	93	177
New Roads (miles)	246	237	120	42	119	32	47	32	42
Well Pads (acres)	621	597	486	106	486	183	386	185	344

Alternatives C and I represents the lowest amount of development, with gas production only occurring on existing federal leases and on GWNF lands that are under private mineral rights. Alternatives E and G do not allow high-volume hydraulic fracturing (HVHF) which greatly reduces the labor, capital investments and natural gas production associated with natural gas drilling; resulting in fewer local jobs and less flow of money through local economies as compared to the alternatives that allow HVHF. Without the need to transport large amounts of water for HVHF, maintenance costs for roads and truck traffic would be greatly reduced. Given the large amount of federal land where the wells associated with Alternatives E and G could be located and the fact that these wells would be drilled over a 15 year time period, the economic and social impacts should be temporary, short-term and minor. The next highest number of wells occurs with Alternatives F and H, where some HVHF would be allowed. However, in Alternative H, these wells would be located on a more concentrated base of administratively available lands so there could be a higher chance of localized impacts. In Alternative H, road construction would be more restrictive so the amount of new roads is comparable to Alternatives E and G but truck traffic and truck weight on those roads and local roads would be increased with HVHF. Given the 15 year time period for less than 200 wells associated with Alternatives F and H, it is likely that impacts would be short-term since permanent gas jobs and creation of new local businesses to support the gas industry would probably not be needed. Yet, if development should occur concurrently on adjacent private lands, there could begin to be cumulative impacts. The remaining alternatives (A, B, and D) would have larger social and economic impacts due to the increased amount of wells, especially horizontal wells, and the amount of road construction.

CUMULATIVE SOCIAL AND ECONOMIC EFFECTS

The Marcellus Shale Play within the Appalachian Basin Province is large and geologically complex, found in parts of Alabama, Georgia, Kentucky, Maryland, New York, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia. The play as a whole is likely to have natural gas drilling and production over an extended period of time. According to a recent U.S. Department of Energy (DOE) report (NETL 2010), the pace of drilling for Marcellus Shale gas wells is expected to triple by 2020, increasing to approximately 30 trillion cubic feet of shale gas, worth more than $200 billion.

With the high investment in the labor and capital resources needed to drill, any natural gas development on GWNF lands would likely also occur with development on private lands. Cumulative effects would include the potential for development on privately owned lands as well as GWNF lands. However, the magnitude of these

effects depend on the pace and scale of development. Effects from minor levels of development would likely be primarily beneficial from the flow of outside spending into the local economy but the benefits would only be for the short-term. With increased development, indirect changes would take the form of increased business for local merchants and professionals (which would also increase the demand for labor), and possibly increased local population if development activities induce people to relocate permanently to the area. Increases in local personal income could result, as well as changes in demand for housing, schools, and public services. The issue is one of capacity and capability of local communities to absorb and accommodate changes in population and requirements for public and private goods and services and whether the area's communities could accommodate inflows of human and material resources that could result from the leases. However, too much development could change the character of the landscape from rural to more of an industrial nature, which could affect retention of residents or tourism attractiveness.

Large projects in close proximity to population centers could affect local communities more profoundly than self-contained, small-scale projects located far from local communities. Projects that encourage large-scale movement of people into an area for short time periods may also present serious challenges to local communities.

An example is provided by Kelsey and others (2012) who reported the local community economic effects for just Bradford County, Pennsylvania. Bradford County is the leading county in the number of Marcellus shale wells in Pennsylvania, with 513 wells drilled between 2008 and 2010 and 1,747 drilling permits issued. Despite the height of activity occurring within the county, they found that the county level employment and income increases suggest that much of the money and jobs are being generated elsewhere due to a small local economy that cannot offer those resources locally. Kelsey found that many of the companies involved in the drilling were regional, national or even international and were bringing in specialized equipment and supplies not directly available from local county-based businesses. Drilling rigs, pipeline and fracing sand were not coming from local sources. However, some were establishing regional offices or facilities within the Marcellus region. Services and supplies that were being purchased locally included aggregate for road and well pad construction, local construction and trucking services, motel rooms and other housing, and food services. An earlier study by Kelsey and others (2011) found that one-third of businesses in Bradford County had sales increased due to Marcellus production and local investments have been made in rails, roads, and hotels. Local nonprofits were reporting major charitable giving by gas companies. They found that according to the US Bureau of Labor Statistics, Bradford County had an increase of more than 1,600 jobs from 2009 to 2010 (total county population in 2010 was 63,000), which is a sharp increase over statewide employment trends. That increase included more than 500 mining jobs, 300 construction jobs, and 140 jobs in the accommodation and food service sector.

Roads System Management

Development of oil and gas resources would require access to the well pads and other facilities. Some of this access would be along existing roads and some would require the construction of new roads. Use of existing roads would likely result in additional maintenance needs which would be funded by the developer. Road construction needs are based on Table 3D-6 and summarized below.

Table 3D-36. Oil and Gas Leasing Road Construction by Alternative (includes federal and private leasing activity)

Activity	Alt A	Alt B	Alts C and I	Alt D	Alt E	Alt F	Alt G	Alt H
Roads (miles)	237	120	42	119	32	47	32	42

It is expected that most roads would only be used to access the drilling activity and would be closed to public use. However, each road would be evaluated at the time of design to determine if it would improve access to other management activities and be managed for other purposes.

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CHAPTER 4 – LIST OF PREPARERS

Name / Education / Experience	Role / Responsibility
Thomas Bailey BS Soil Science (1976); 32 years' experience in the collection, evaluation, mapping and interpretation of soil resource information.	Interdisciplinary Team Member, Soil Resources
JoBeth Brown BA Sociology (1984); 23 years' experience in public affairs and collaboration.	Public Affairs Officer
Ted Coffman BLA Landscape Architecture and BS Horticulture (1980, 1979);3 0 years of experience involving visual resources and the design and administration of recreation, Wilderness, and trails.	Recreation Staff Officer
Thomas K. Collins BA Geology (1965); Graduate Study in Geology; 35 years of experience in the inventory and evaluation of minerals, geologic resources and geologic hazards.	Interdisciplinary Team Member, Geology
Carol Croy BS Wildlife and Fisheries (1987), MS Wildlife Ecology (1991), PhD Wildlife Ecology (2003); 26 years' experience in inventorying, monitoring and management of plant and animal species, including rare, endangered and sensitive species; 10 years' experience in research of prescribed fire effects on flora and fauna communities.	Interdisciplinary Team Member, Wildlife Resources
Steve Croy BS Wildlife Biology and Botany (1977); 35 years' experience involving the inventory, management, and monitoring for threatened, endangered, and rare plant and animal species, 22 years fire ecology and management experience.	Interdisciplinary Team Member, Sensitive Plant and Animal Resources, Fire
Cindy M. Huber BS Forestry (1976); MS Entomology (1981); 11 years of experience in assessing the impacts of insect and disease pests on forest resources, 17 years' experience in monitoring and evaluating the effects of air pollution on natural resources and visibility.	Interdisciplinary Team Member, Air Resources (retired)
Fred Huber BA Biology (1972); MS Botany (1976); Graduate Study in physiological ecology of alpine plant species; 24 years of experience in identifying and evaluation sensitive plant and animal resources and habitats.	Interdisciplinary Team Member, Sensitive Plant Resources
Dawn Kirk BA Biology/Environmental Studies (1990); MS Fisheries (1992); Graduate Study in aquatic ecology and benthic macroinvertebrates, 21 years of experience in monitoring and evaluating aquatic habitats and fisheries management.	Interdisciplinary Team Member, Aquatic Resources

Name / Education / Experience	Role / Responsibility
Ken Landgraf BS Water Resource Science and Biology (1978); 13 years' experience in NEPA and Forest Planning, 24 years of experience in collecting, interpreting information on water, air and soils.	Interdisciplinary Team Member, Planning Staff Officer
Russ MacFarlane BSF Forest Resource Management (1985); 20 years' experience in timber planning/silviculture, 11 years' experience in pest management.	Interdisciplinary Team Member, Silviculture
Al McPherson BA Biology (1973); 17 years' experience in the administration and monitoring of recreation, wilderness, and trails programs.	Interdisciplinary Team Member, Recreation (retired)
James O'Hear BS Geography (1986); 25 years in GIS and forest planning.	Interdisciplinary Team Member, Geographic Information Systems
Karen Overcash BS Forest Resource Management (1985); MS Forest Biometrics (1988); 25 years of experience in land management planning.	Interdisciplinary Team Leader, Planning Analyst, NEPA
Richard Patton MS Forest Management/Hydrology (1980); 32 years' experience in inventory and evaluation of water resources.	Interdisciplinary Team Member, Hydrology
Dave Plunkett Bachelor of Science, Forestry, Penn State University (1975); 26 years' experience with U.S. Forest Service as forester and planner at Ranger District and Supervisor's Office level on 4 National Forests in 3 Forest Service Regions and Northeast Forest Experiment Station.	Interdisciplinary Team Member, Planning and NEPA (retired)
Scott Vandegrift BS Construction Engineering (1995); 22 years civil engineering experience including 18 years of facility and transportation management	Interdisciplinary Team Member, Engineering and Lands
Ginny Williams BLA Landscape Architecture (1990); 23 years of experience involving visual resources, developed recreation, trails, Wilderness and design.	Interdisciplinary Team Member, Scenery and Recreation Resources

CHAPTER 5 – FEIS DISTRIBUTION LIST

Copies of the Final Environmental Impact Statement were sent to the following federal agencies:

USDA, National Agricultural Library
Environmental Protection Agency
DOI Bureau of Land Management
USDI Fish & Wildlife Service

Notification that the Final Environmental Impact Statement is available on the web was sent to the following federal agencies:

Advisory Council on Historic Preservation
Chief of Naval Operations, Energy and Environmental Readiness Division
Director, Office of Environmental Policy and Compliance
Federal Aviation Administration
Federal Highway Administration
National Marine Fisheries Service
Natural Resources Conservation Service
NOAA Office of Policy and Strategic Planning
Ohio River Basins Commission
Rural Utilities Service (RUS)
U.S. Army Engineer Great Lakes and Ohio
U.S. Army Engineer North Atlantic Division
U.S. Coast Guard (USCG)
U.S. Department of Energy
U.S. Department of the Interior, Office of Environmental Policy and Compliance
USDA APHIS PPD/EAD
USDA Office of Civil Rights

The following individuals or groups were sent a hard copy of the FEIS.

Shawn Head, West Virginia Division of Natural Resources
Barbara Sargent, West Virginia Division of Natural Resources
Chuck Waggy, West Virginia Division of Natural Resources
Kieran O'Malley, West Virginia Division of Natural Resources
Mike Eye, Shenandoah WMA
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Sarah Francisco & David Carr Jr., Southern Environmental Law Center
John P Cone Jr., Citizens Task Force
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David Hook, MidAtlantic 4WD Association
John Hutchinson
Laura Neale, Virginia Wilderness Committee
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The following individuals or organizations were sent a computer disk.

Dr. Dan Downey, Trout Unlimited Massanutten Chapter
Jill Keihn, Northern Shenandoah Valley Planning District Commission
Sherry Ryder, Bath County Planning
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Lynn Cameron, Friends of Shenandoah Mountain
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Lynn Williams
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Pete Davis, Lexington News-Gazette
Pete & Lee Meyer
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John Hancock, MeadWestvaco
Michell Hicks, Eastern Band of Cherokee
Jerry Jacobsen
Thomas Jenkins, Shenandoah Mountain Bike Club
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Andy Morris, Town of Clifton Forge
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Charles Newton
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Joseph Paxton, Rockingham County Administrator
Robert Proudman, Appalachian Trail Conservancy
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